YMB1805
IO Type 8 bit OTP MCU
with Lithium battery and H-bridge
Datasheet

Version 0.00 – Oct.31, 2023

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Revision History

Revision	Date	Description
0.00	2023/10/31	Preliminary version

Usage Warning

User must read all application notes of the IC by detail before using it. Please download the related application notes from the following link:

http://www.padauk.com.tw/en/technical/index.aspx

1. General Description

The YMB1805 series mainly includes two parts:

- PMB180 MCU
- 4 MOS form H-bridge driver module

Among them, PMB180 is a built-in 1.25KW OTP data memory and 64-byte data memory, a hardware comparator for comparing the signal or internal reference voltage Vinternal-R or internal bandgap reference voltage Band-gap between two pins. PMB180 also provides three hardware timers: a 16-bit timer, an 8-bit timer (can be output in PWM mode), and a set of 3 sets of 11-bit PWM timers/generators (LPWMG0, LPWMG1 and LPWMG2), support Mini-C/ASM language, easy to program. For details on the use of the PMB 180, please refer to the "PMB180 Specification" on the official website of PADAUK Technology.

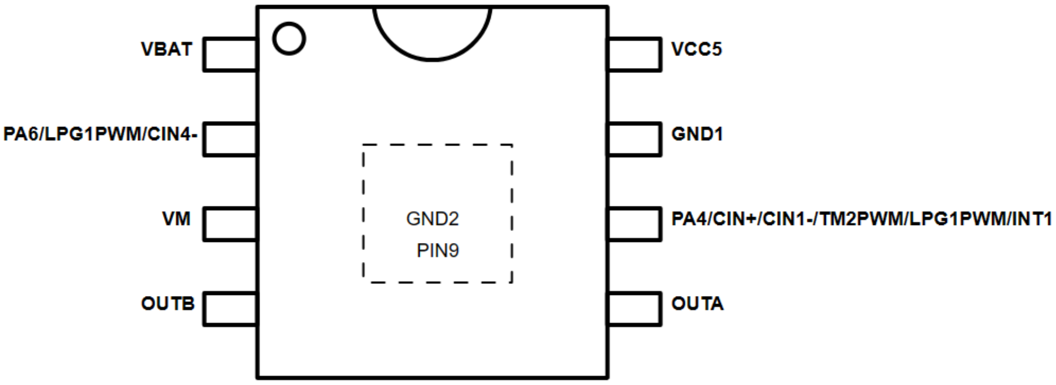
The main storage space of the YMB1805 program is as follows:

- OTP ROM (Word): 1.25KW
- SRAM (Byte): 64

2. Application

- Intelligent Hardware
- Mobile Phone Holder
- Intelligent door locks
- Handheld mini fan
- Related applications requiring motor forward and reverse rotation

3. Ordering/ Package Information



YMB1805-ES08A (ESOP8A-150mil)

Note: PA1 TO IN1, PA5 TO IN2 (unpackaged Pin)

Pin Name	Input / Output				Special features				
	I / O	Pull-high	Wake-up	Open drain output	Comparator	PWM	Charging	H Bridge	Writing
VBAT							√		√
PA6	√	√	√		CIN4-	LPG1			√
VM								√	
OUTB								√	
OUTA								√	
PA4	√	√	√		CIN+ CIN-	TM2 LPG1			√
GND1							√		
VCC5							√		
GND2							√	√	√
INA / PA1	√	√	√			**LPG0**		√	
INB / PA5	√	√	√			**LPG2**		√	

H-bridge control logic input: INA/PA1 and **INB/PA5 (unpackaged Pin)**

H-bridge power supply: VM and GND2 (connect 10uF or more capacitance between VM and ground)

H-bridge output: OUTA/OUTB

4. H-Bridge Drive Module Description/Features

4.1. H-Bridge drive module description

The YMB1805 is an integrated motor driver solution for consumer products, smart hardware and battery powered motion control applications.

The H-bridge driver module of YMB1805 can drive a brushed DC motor, which can realize four functions of motor forward/reverse/stop/brake.

The H-bridge driver module of YMB1805 supports a maximum operating voltage of 7.5V, a continuous current of 1.0A, and a peak current of 2.0A. At the same time, it integrates protection functions such as over-temperature protection and under-voltage blocking.

The H-bridge driver module of YMB1805 has two PWM (INA/INB) input interfaces, INA is connected to PA1, INB is connected to PA5

4.2. H-Bridge drive module features

- Operating voltage range 2.0 - 7.5V
- Continuous current 1.0A, peak 2.0A
- Low on-resistance: 450mΩ (HS+LS)@4.2V
- Low standby current
- Low quiescent operating current
- Over temperature protection
- Undervoltage protection

5. H-bridge drive module device characteristics

5.1. Device Characteristics (VM = 4.2V, Ta = 25°C):

Parameter		Test conditions	Min	Typ	Max	Unit
On-resistance						
FET On-resistance	R_{DSON}	I_{OUT}=1A		0.45	0.60	Ω
INA/INB						
High Level Input Voltage	V_{INH}		Vbat		VM	V
Low Level Input Voltage	V_{INL}		0		0.8	V
Pull-down resistor	R_{PD}			110	200	KΩ
Operating Current						
Circuit shutdown current	I_{VM_OFF}	INA=INB=0		0.0	2.0	uA
Circuit operating current	I_{VM_ON}			0.4	0.8	mA
Protecting Characteristics						
Temperature rise protection point	T_{OTSD}			170		°C
Temperature hysteresis	T_{HYS}			60		°C
VM Rising Undervoltage protection	V_{UVLO_R}	VM Rise		1.8	2.0	V
VM Fall Undervoltage Protection	V_{UVLO_F}	VM Drop		1.6	1.8	V

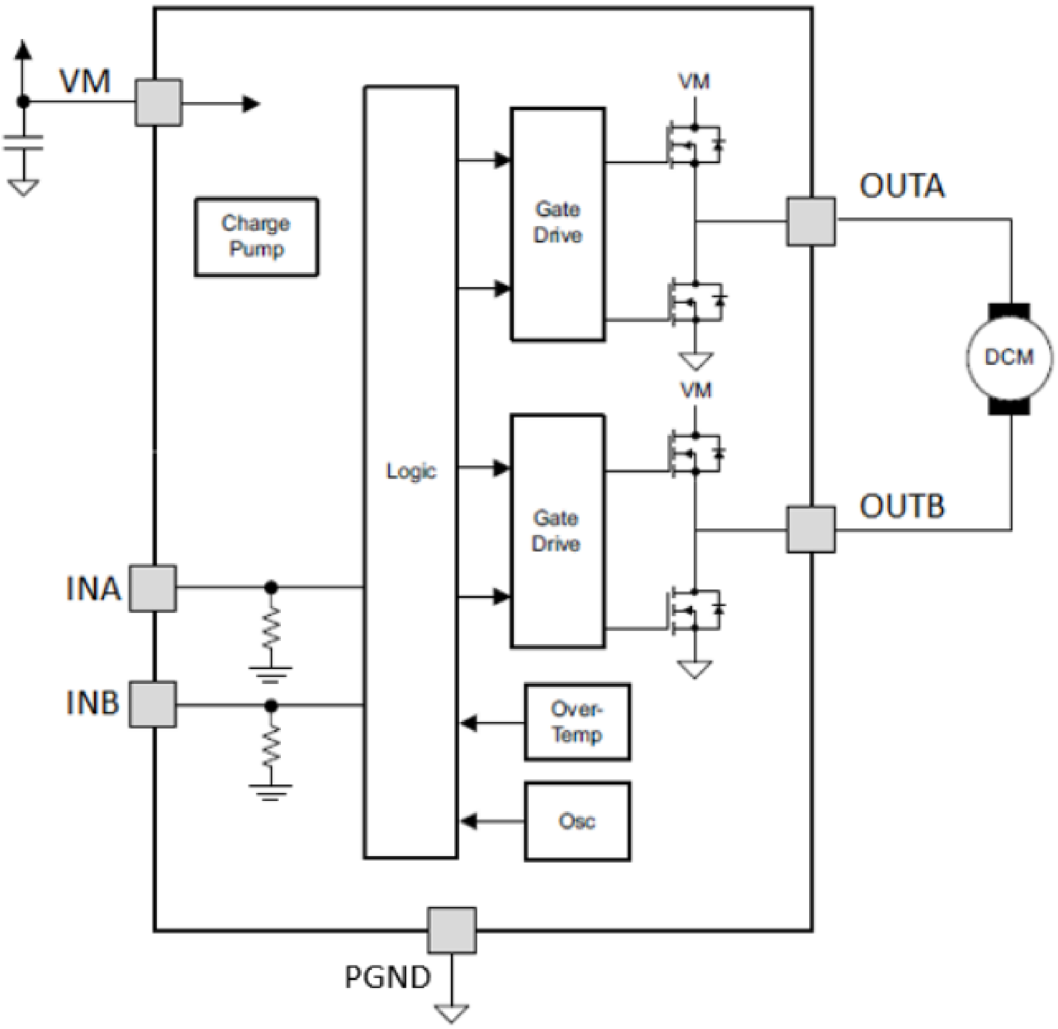
5.2. Absolute maximum quota

Parameter		Min	Max	Unit
Supply voltage	VM	-0.3	8.0	V
ESD protection (HBM)	VM, OUTA,OUTB	5.0		KV
Operating temperature	T_J	-40	150	ºC
Storage temperature	T_{stg}	-65	150	ºC
Thermal resistance	θ_{JA}		100	ºC/w

5.3. Recommended operating range values

Parameter		Min	Max	Unit
Supply voltage	VM	2.0	7.5	V
Input voltage	INA, INB	0	Vbat (≦5.0)	V
Output current	I_{OUTA}, I_{OUTB}	0	1.0	A

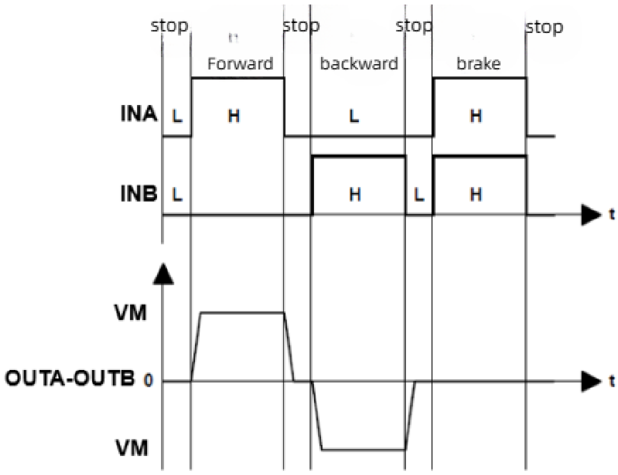
6. Functional block diagram and application description of H-bridge driver module



6.1. Input-output logic table

INA	INB	OOUTA	OUTB	state	current
L	L	Hi-Z	Hi-Z	standby	I_{VM_OFF}
H	L	H	L	forward	I_{VM_ON}
L	H	L	H	backwards	I_{VM_ON}
H	H	L	L	brake	I_{VM_ON}

6.2. Input-output waveform



6.3. Application note

6.3.1. Basic mode of operation

a) Standby mode

In standby mode, INA=INB=L. All internal circuits, including the driver power tubes, are turned off. The circuitry draws very low current. The motor outputs OUTA and OUTB are in a high resistance state.

b) Forward mode

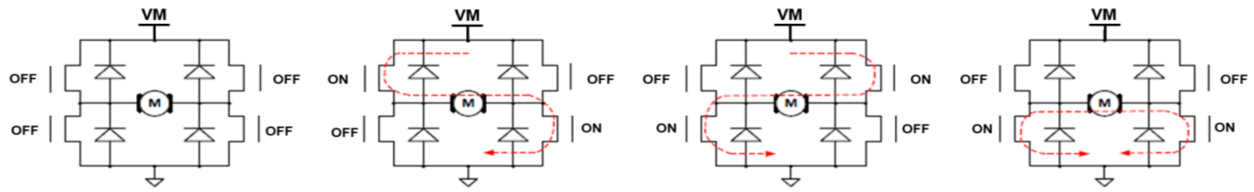
The forward mode is defined as: INA=H, INB=L, at this time the motor drive end OUTA output high level, the motor drive end OUTB output low level, the motor drive current from OUTA into the motor, from OUTB to the ground, at this time the rotation of the motor is defined as the forward mode.

c) Invert mode

The reverse mode is defined as: INA=L, INB=H, at this time the motor drive end OUTB output high level, the motor drive end OUTA output low level, the motor drive current from OUTB into the motor, from OUTA to ground, at this time the rotation of the motor is defined as the reversal mode.

d) Brake mode

The braking mode is defined as: INA=H, INB=H, at this time the motor drive end OUTA and OUTB are output low level, the energy stored in the motor will be quickly released through the NMOS tube at the OUTA end or NMOS at the OUTB end, and the motor will stop rotating in a short time. Note that in brake mode, the circuit consumes quiescent power.

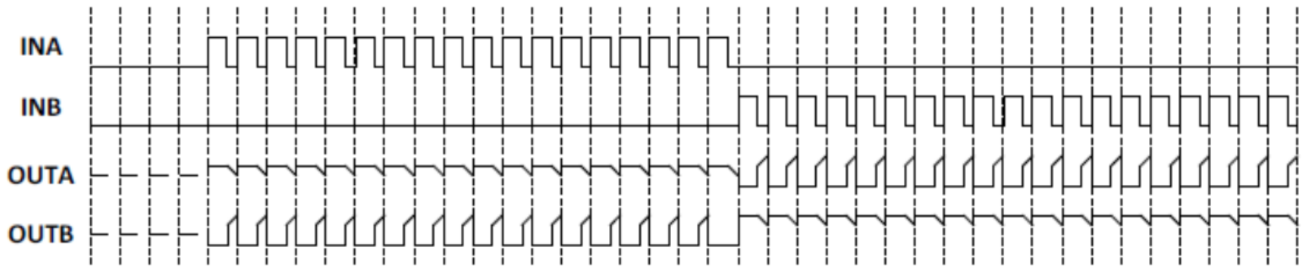


a) standby mode **b)** forward mode **c)** Invert mode **d)** Brake mode

e) PWM mode A

When the input signal INA is a PWM signal, INB=0 or INA=0, INB is a PWM signal, the rotation speed of the motor will be controlled by the duty cycle of the PWM signal. In this mode, the motor drive circuit switches between conduction and standby mode, in which all power tubes are turned off and the energy stored inside the motor can only be slowly released through the body diode of the power MOSFET.

Note: Due to the presence of high impedance in the operating state, the speed of the motor cannot be precisely controlled by the duty cycle of the PWM signal. If the frequency of the PWM signal is too high, the motor will not start.

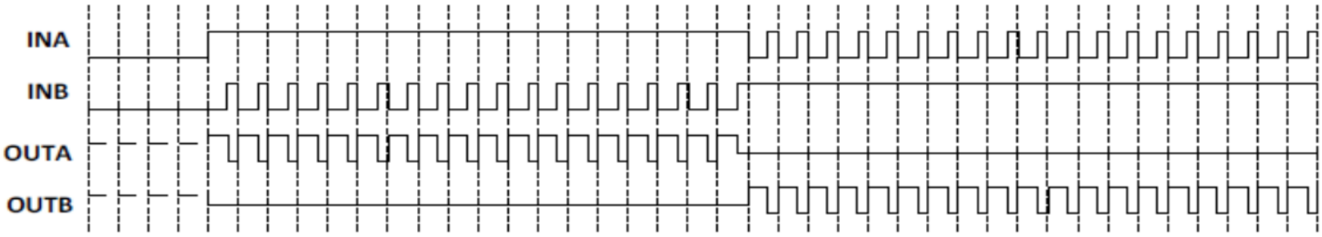


PWM mode A Schematic diagram of the signal waveform

f) PWM mode B

When the input signal INA is a PWM signal, INB=1 or INA=1, INB is a PWM signal, the rotation speed of the motor will be controlled by the duty cycle of the PWM signal. In this mode, the motor drive circuit outputs between the conduction and brake modes, and in the brake mode, the energy stored by the motor is quickly released through the low-side NMOS.

Note: Due to the braking state in the working state, the motor energy can be released quickly, and the speed of the motor can be accurately controlled by the duty cycle of the PWM signal, but it must be noted that if the PWM signal frequency is too low, the motor will not be able to rotate smoothly continuously due to entering the braking mode. In order to reduce motor noise, it is recommended that the PWM signal frequency be greater than 20KHz and less than 50KHz.



PWM mode B Schematic diagram of the signal waveform

6.3.2. Anti-common-state conduction circuit

In a full-bridge drive circuit, the state in which the high-side NMOS power tube and the low-side NMOS power tube in the half-bridge are turned on at the same time is called the common-state on state. Common-state conduction creates a power-to-ground transient high current that causes additional power dissipation losses and, in extreme cases, burns the circuit. With built-in dead time, common-state conduction is avoided. A typical dead time is 300ns.

6.3.3. Over temperature protection circuit

When the junction temperature of the drive circuit exceeds the preset temperature (typical value is 170℃), the TSD circuit begins to operate, at which point the control circuit forces off all output power tubes, and the output of the drive circuit enters a high-impedance state. TSD circuits are designed with thermal hysteresis to return to normal operation only when the junction temperature of the circuit drops to a preset temperature (110℃ typical).

6.3.4. Maximum continuous power consumption of drive circuit

This series of motor drive circuits are designed with overheating protection circuits inside, so when the power consumption of the drive circuit is too large, the circuit will enter the thermal shutdown mode, and the motor will not work normally in the thermal shutdown state. The calculation formula for the maximum continuous power consumption of the drive circuit is:

$$P_M = (170°\mathrm{C} - T_A) / \theta_{JA}$$

Among them, 170℃ is the preset temperature point of the thermal shutdown circuit, TA is the ambient temperature (℃) of the circuit operation, and $\theta_{JA}$is the thermal resistance (unit ℃/W) from the junction of the circuit to the environment.

Note: The maximum continuous power consumption of the driver circuit is related to factors such as ambient temperature, packaging form and heat dissipation design, and is not directly related to the internal resistance of the circuit conduction.

6.3.5. Drive circuit power consumption

The on-internal resistance of the internal power MOSFET of the motor drive circuit is the main factor affecting the power consumption of the drive circuit. The power consumption of the drive circuit is calculated as follows:

$$P_D = I_L^2 \times R_{ON}$$

Where I_L represents the output current of the motor drive circuit and R_{ON} represents the on-internal resistance of the power MOSFET.

Note: The on-internal resistance of a power MOSFET increases with temperature, and the temperature characteristics of the on-resistance must be considered in calculating the maximum continuous output current of the circuit as well as the power time.

6.3.6. Maximum continuous output current of the drive circuit

According to the maximum continuous power consumption of the drive circuit and the power consumption of the drive circuit, the maximum continuous output current of the drive circuit can be calculated, and the calculation formula is:

$$I_L = \sqrt[2]{(170°\text{C} - T_A)/\left(\theta_{JA} \times R_{ONT}\right)}$$

The R_{ONT} is the power MOSFET conduction internal resistance after considering temperature characteristics.

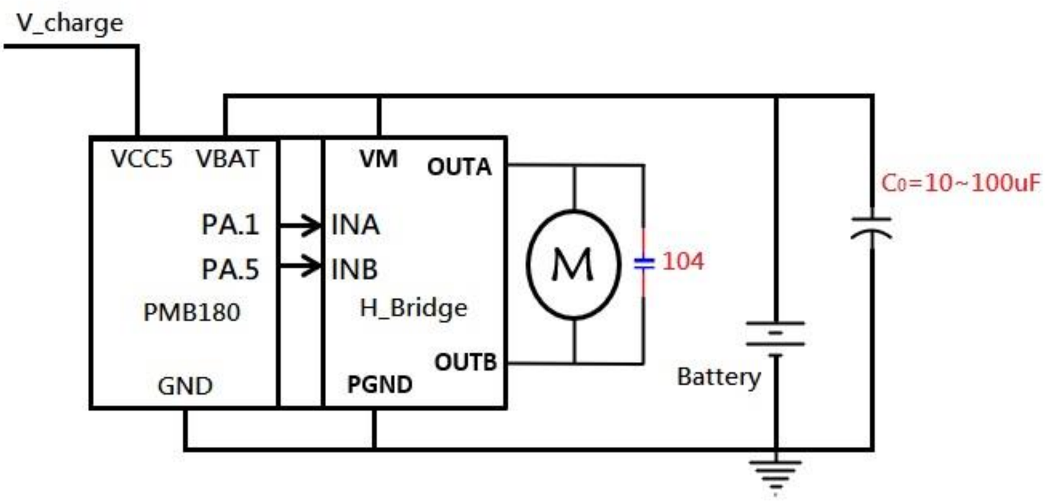
Note: The maximum continuous output current of the driver circuit is related to factors such as ambient temperature, package form, thermal design, and the conduction internal resistance of the power MOSFET.

6.3.7. Motor internal resistance selection

The above analysis shows that the maximum sustained power consumption of the motor drive circuit is limited. If the internal resistance of the motor driven by the motor drive circuit is extremely small, and its blocking current exceeds the maximum continuous output current that the motor drive circuit can withstand too much, it is easy to cause the motor drive circuit to enter the overheating shutdown state, and the motor will appear to jitter when repeatedly advancing and retreating. When selecting a motor drive circuit, the internal resistance of the motor must be considered.

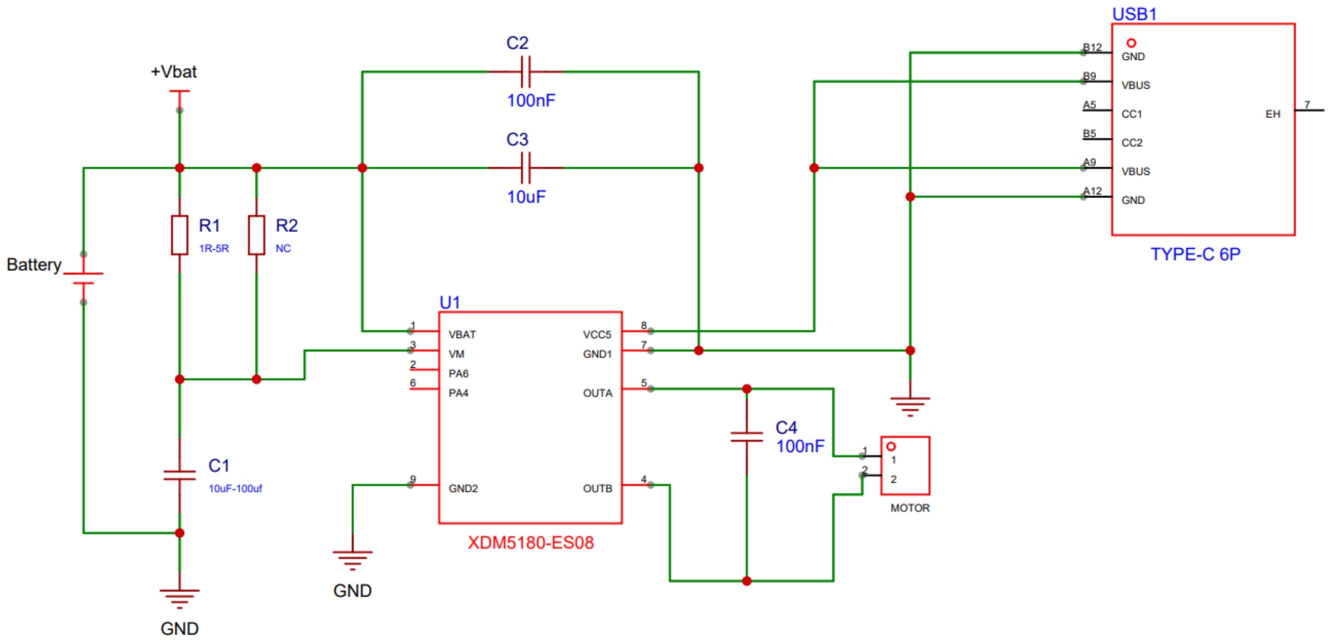
7. Application reference circuit

7.1. Application wiring diagram



Notes: The capacitance value of C_0 is adjusted according to the application requirements.

7.2. Application reference circuit



8. Precautions for the use of YMB1805

(1) The recommended circuit and parameters are only suitable for ordinary DC motor drive, please use them according to the actual situation.

(2) The continuous current driving capability of the H-bridge drive module is affected by factors such as package form, VM, chip difference, ambient temperature, PCB material and thickness. The specification gives

(3) Parameters are for reference only. In actual use, please consider a certain margin according to the product.

(4) The decoupling capacitor near the power supply end of the H-bridge drive module must be connected nearby and must be added, otherwise it will easily cause circuit breakdown; the power supply decoupling capacitor to the ground.

(5) The capacitance value can be adjusted appropriately according to the motor, and the capacitance value given in the figure is the reference value.

(6) The 104 capacitor connected between OUTA and OUTB is a bypass capacitor, which can effectively improve the voltage spike breakdown output caused by the fast forward and reverse switching of the motor.

(7) Port problem.

(8) YMB1805 is designed and manufactured by MOS process and is sensitive to static electricity. It is required to pay attention to anti-static measures in the whole process of packaging, transportation, processing and production.

(9) The current value at the moment of motor start is recommended not to exceed 2.5A.

(10) For the PCB layout guide of E-PAD products, please refer to the APN019 application manual on PADAUK Technology's official website.

http://www.padauk.com.tw/en/technical/index.aspx?kind=9

(11) If you have any questions about using the product, please consult the FAE of PADAUK Technology.

9. Programming Writing

There are 4 pins for using the writer to program: PA4，PA6，VBAT and GND.

Please use 5S-P-003 or later version to program YMB1805 real chip. (3S-P-002 or elder versions do not support programming YMB1805)

Add package information and OS settings to the writing file

Method 1: Add the command set by sealing in the original program code:

.writer package 8, 1, 0, 0, 6, 0, 2, 0, 7, 0x000F, 0x0006, 0, 0x04 // for P003B

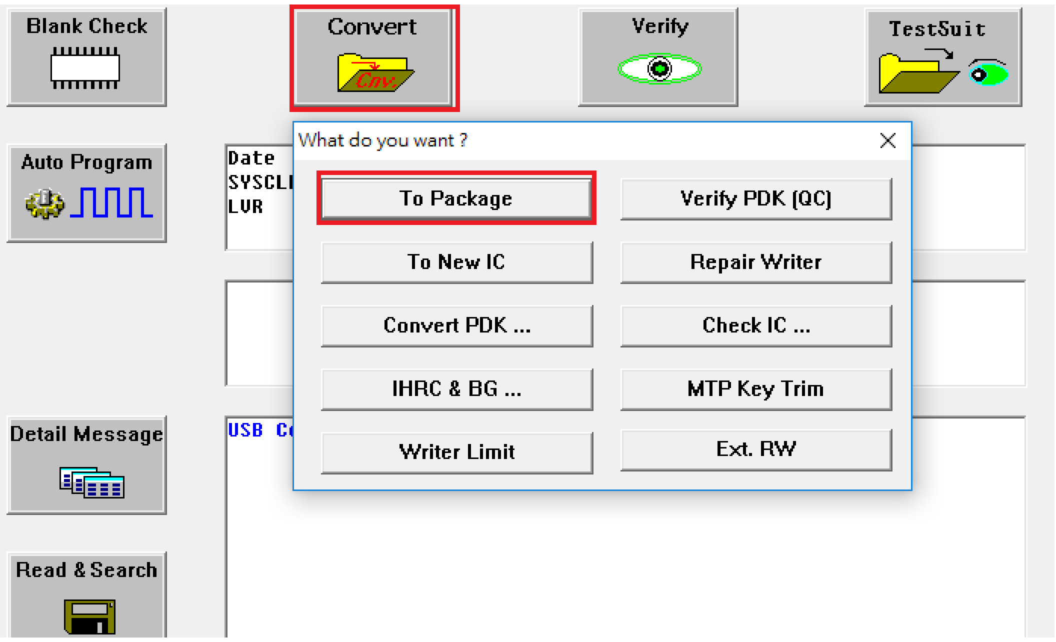
.writer package 8, 0, 0, 0, 6, 1, 2, 0, 7, 0x000F, 0x0006, 0, 0x014 // PA5 and VDD exchange

Method 2: After the user downloads the PDK file to be recorded on the Load File page of the Writer software, he can follow the following steps to enter the Package Setting page: Convert > To Package > Select to write the PDK file > Package Setting, as shown in the figure below.

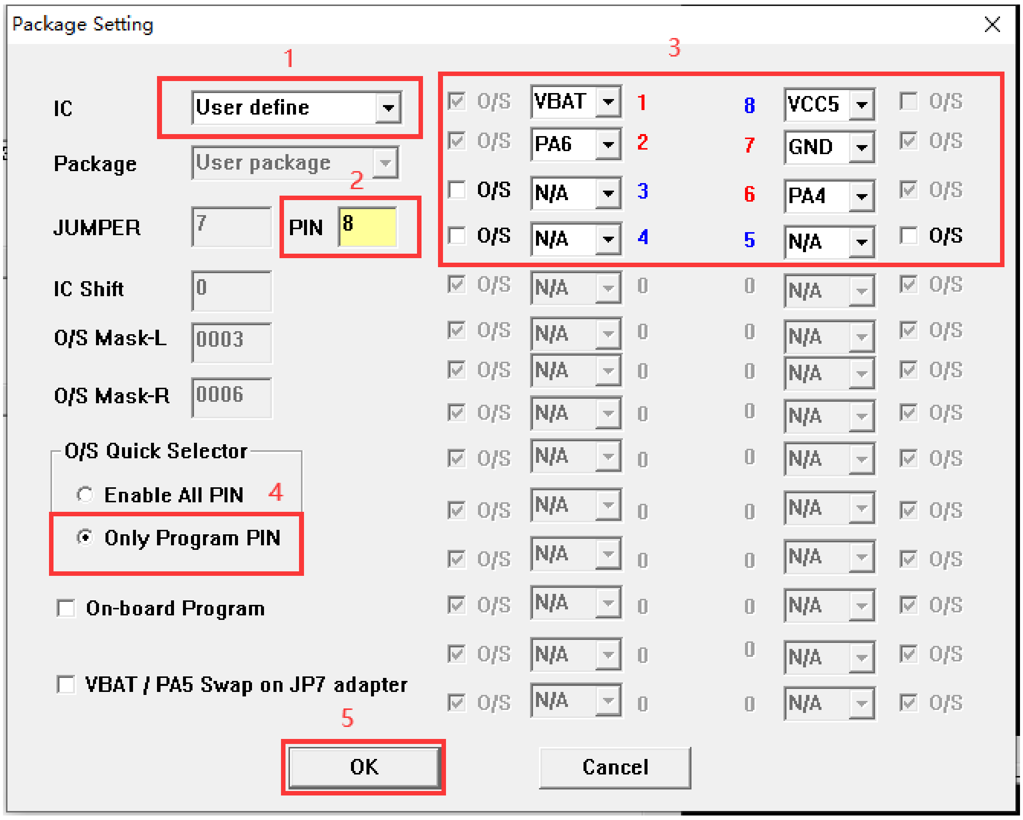
1. IC selects **User Define**, after which JP information will automatically jump to JP7:
2. The number of PIN pins is 8, depending on the writing situation.
3. Add the corresponding recording pin number and position of YMB1805-ES08 on the right.
4. The user needs to set Open/Short to test only the writing foot: tick O/S Test **Only Program PIN**.

   Note: **Please select this setting**, otherwise it may affect the normal progress of Writing.
5. Select OK and archive.

Finally, the IC is placed on the top grid on the front of the recorder, and the chip PIN1 is on the first foot on the upper left of the textool.



Convert PDK



Package Setting

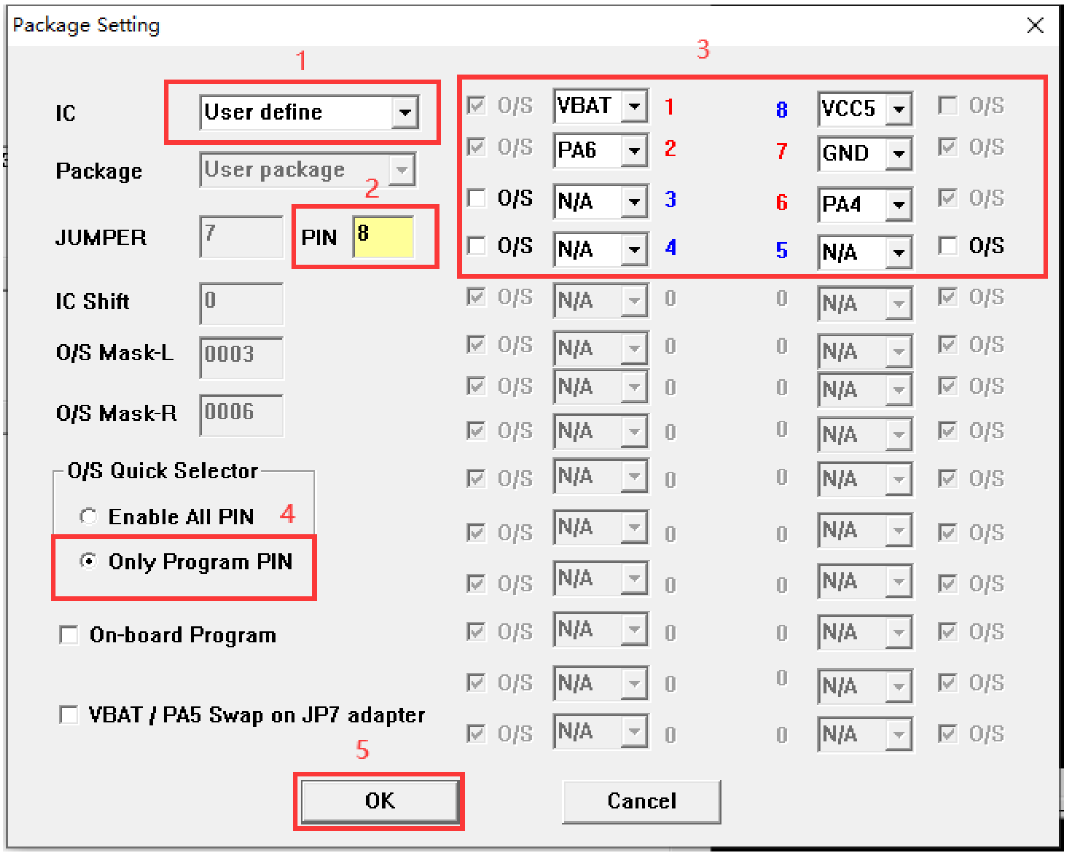
9.1. Using 5S-P-003B to write YMB1805

For 5S-P-003B to write PMB180, Use jumper7 to adapt program signal connection. The connection of signal depend on the IC package. Please refer to. Chapter 5 of the Writer user manual to find example and make the jumper-7 adaptive board for target IC package. User can get the user manual from the following linker web page.

http://www.padauk.com.tw/en/technical/index.aspx?kind=27

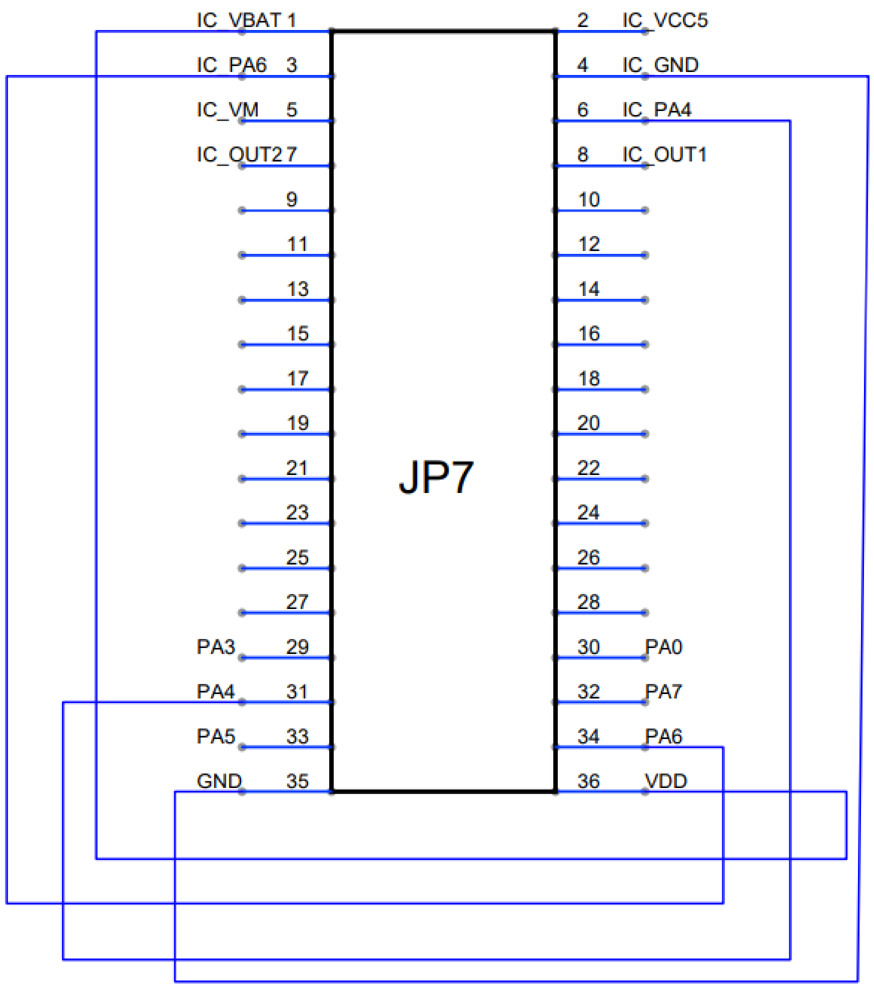
1. Use the .writer package 8, 1, 0, 0, 6, 0, 2, 0, 7, 0x000F, 0x0006, 0, 0x04 commands for P003B package setting.

2. Load PDK from GUI, insert JP7 and then input IC on the socket without shift. After LCDM displays IC ready, it can be written.



YMB1805-ES08 in P003B package setting

For example, make JP7 writer signal connection of YMB1805-ES08, as the following:



schematic diagram of Jumper7 for P003B

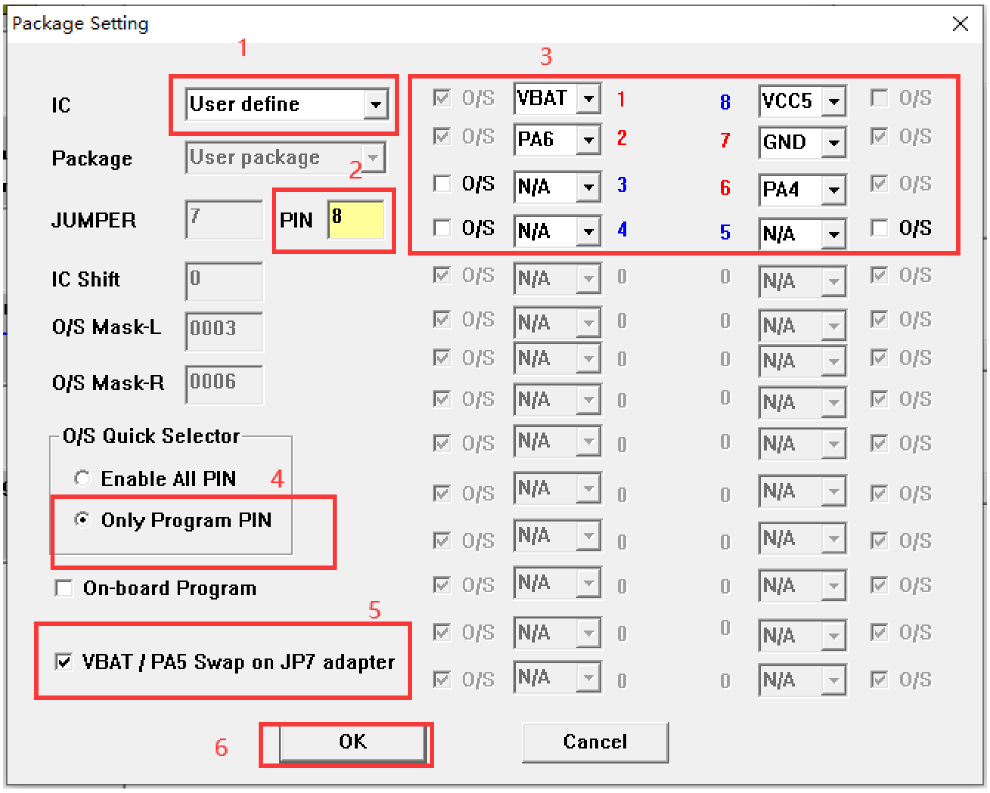
9.2. Using 5S-P-003 to write YMB1805

5S-P-003 and 5S-P-003B writing YMB1805 in the likely way. But user should be take care the following thing.

1. Use the .writer package 8, 0, 0, 0, 6, 1, 2, 0, 7, 0x000F, 0x0006, 0, 0x014 commands for P003B package setting

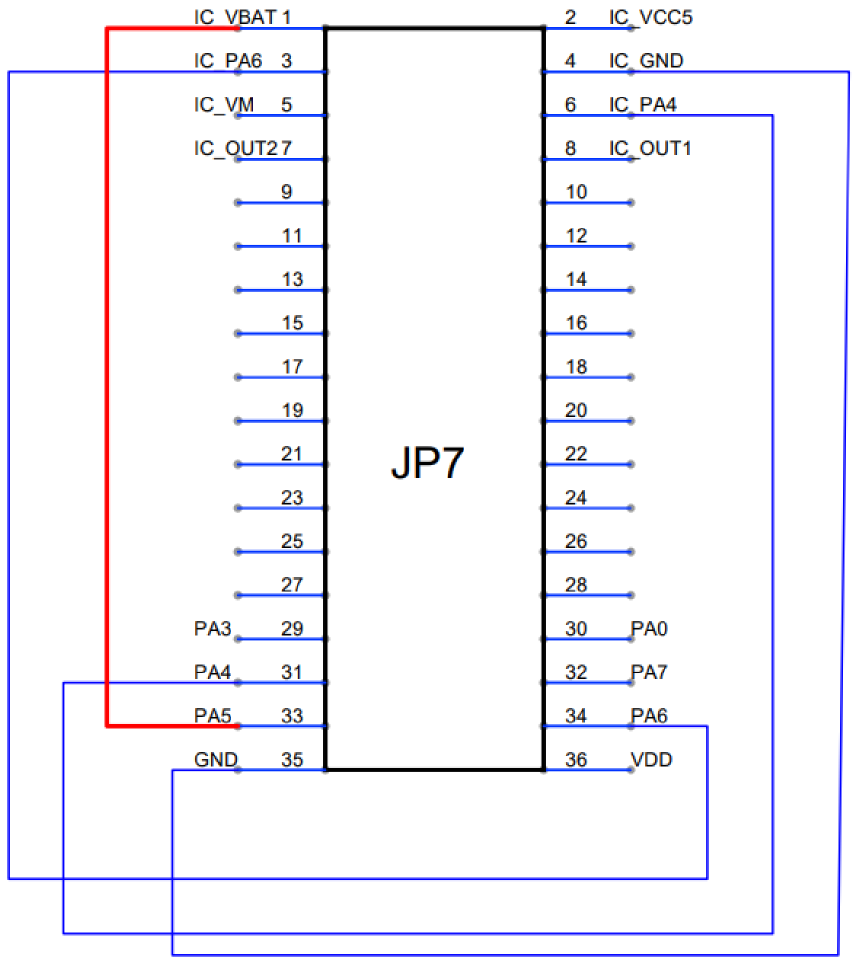
2. Convert the PDK file from GUI

   Enter the writing interface from the IDE, then click "Convert" -> "To Package". In the “Package Setting" interface, select the “user defined”, then click “**VBAT /PA5 Swap on JP7 adapter**”. After confirming information about the IC pin, save and use the newly generated PDK file. Please refer to picture for specific operation steps.



YMB1805-ES08 in P003 package setting

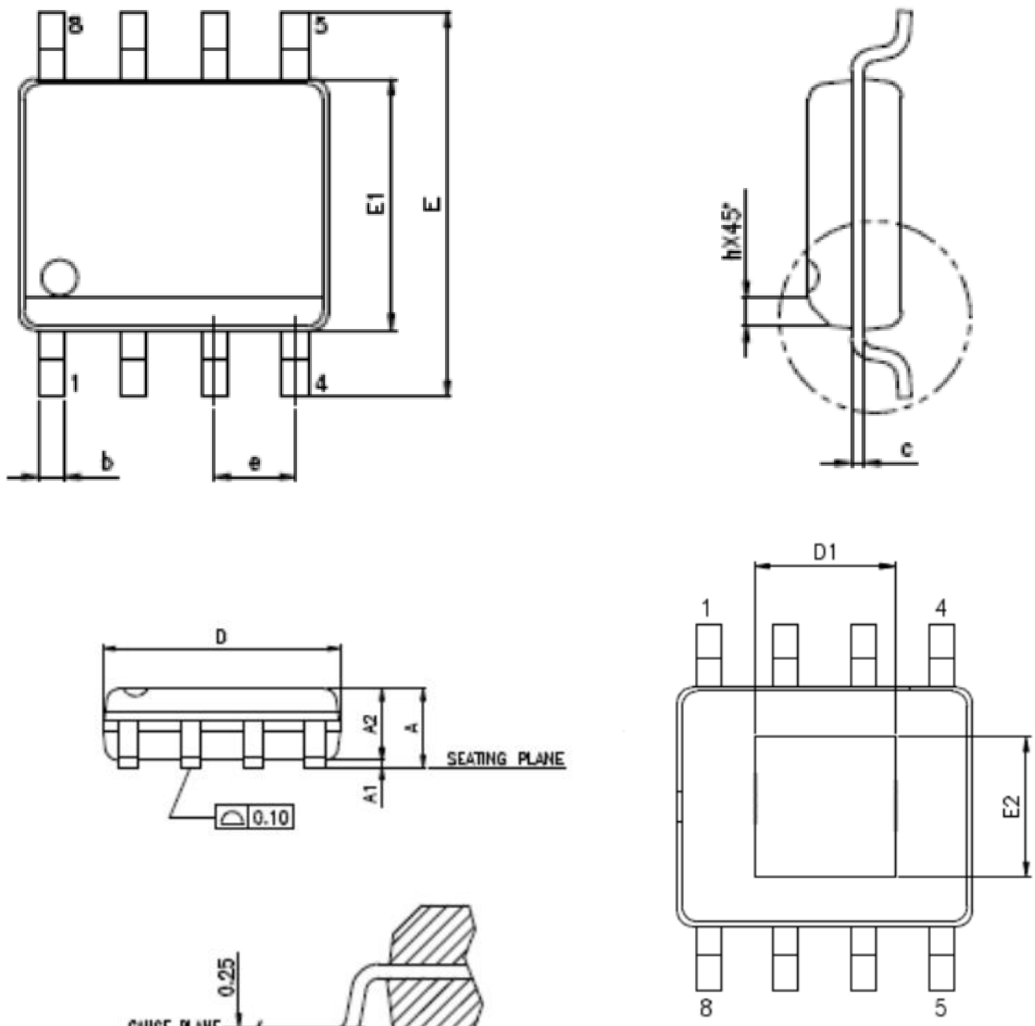
For example, make JP7 writer signal connection of YMB1805-ES08, as the following:



schematic diagram of Jumper7 for P003

10. Package information

10.1. ESOP08 (Pitch=1.27 mm=0.05 inch, Body Width=3.9 mm=150 mil)



	MILLIMETERS	
SYMBOLS	MIN	MAX
A	-	1.75
A1	0.10	0.25
A2	1.25	-
b	0.31	0.51
c	0.10	0.25
D	4.90 BSC	
E	6.00 BSC	
E1	3.90 BSC	
e	1.27 BSC	
L	0.40	1.27
h	0.25	0.50
θ °	0	8
D1	3.20	3.40
E2	2.10	2.50

1. E-PAD dimensions are for reference only
2. E-PAD：Refer to PMC-APN-019 E-PAD product PCB layout guideline