SmartDriveDuo-30

MDDS30

User's Manual

Rev 1.11

July 2019

INDEX

1. INTRODUCTION

SmartDriveDuo-30 is one of the latest smart series motor drivers designed to drive medium power brushed DC motor with current capacity up to 80A peak (few seconds) and 30A continuously, each channel. This driver is designed specially for controlling differential drive mobile robot using RC controller. Nevertheless, MDDS30 also can be controlled using analog joystick or microcontroller (PWM, Serial). MOSFETs are switched at 18 KHz to ensure quiet operation and no annoying whining sound. Besides, it also equipped with a microcontroller unit to provide smart features such as multiple input mode and thermal protection.

"SmartDriveDuo-30's feature makes driving a robot with differential drive a truly plug and play experience"

Some of the features for SmartDriveDuo-30 are summarized as below:
● Bi-directional control for dual brushed DC motor.
● Support motor voltage from 7V to 35V.
● Maximum current up to 80A peak (1 second), 30A continuously, each channel.
● On board MOSFETs are switched at 18 KHz for quiet operation.
● Battery low voltage indicator.
● Battery over voltage indicator.
● Thermal protection.
● Current limit protection.
● Multiple input modes: RC, Analog/PWM, Serial Simplified and Serial Packetized.
● On board push buttons for fast test and manual operation.
● **NO POLARITY PROTECTION FOR V MOTOR.**

2. PACKING LIST

Please check the parts and components according to the packing list. If there are any parts missing, please contact us at sales@cytron.io immediately.
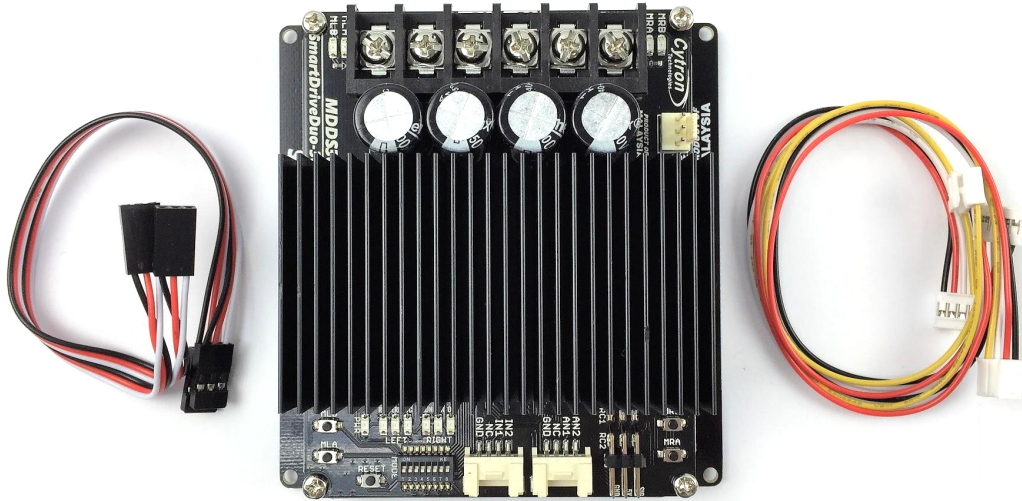
| No	ITEMS	QUANTITY
1	SmartDriveDuo-30 (Code: MDDS30)	1
2	Grove 4 Pin Buckled 20cm Cable (Code: WR-EX-GROVE)	2
3	2561 3 Ways Connector Extension Wire (Code: WR-EX-2561-03)	2

Optional External Fan (Not included):

No	ITEMS	QUANTITY
1	DC5V Brushless Fan 40 x 40 x 20mm (Code: FAN-05-040040020)	1
2	PCB Stand (Screw & Screw) 30mm (Code: SD-SS-30)	4
3	Bolt M3 x 25mm (Code: HD-PM-M3-25)	4
4	M3 Nut (Code: HD-PM-M3-NUT)	4

3. PRODUCT SPECIFICATIONS

Dimension (unit in mm):
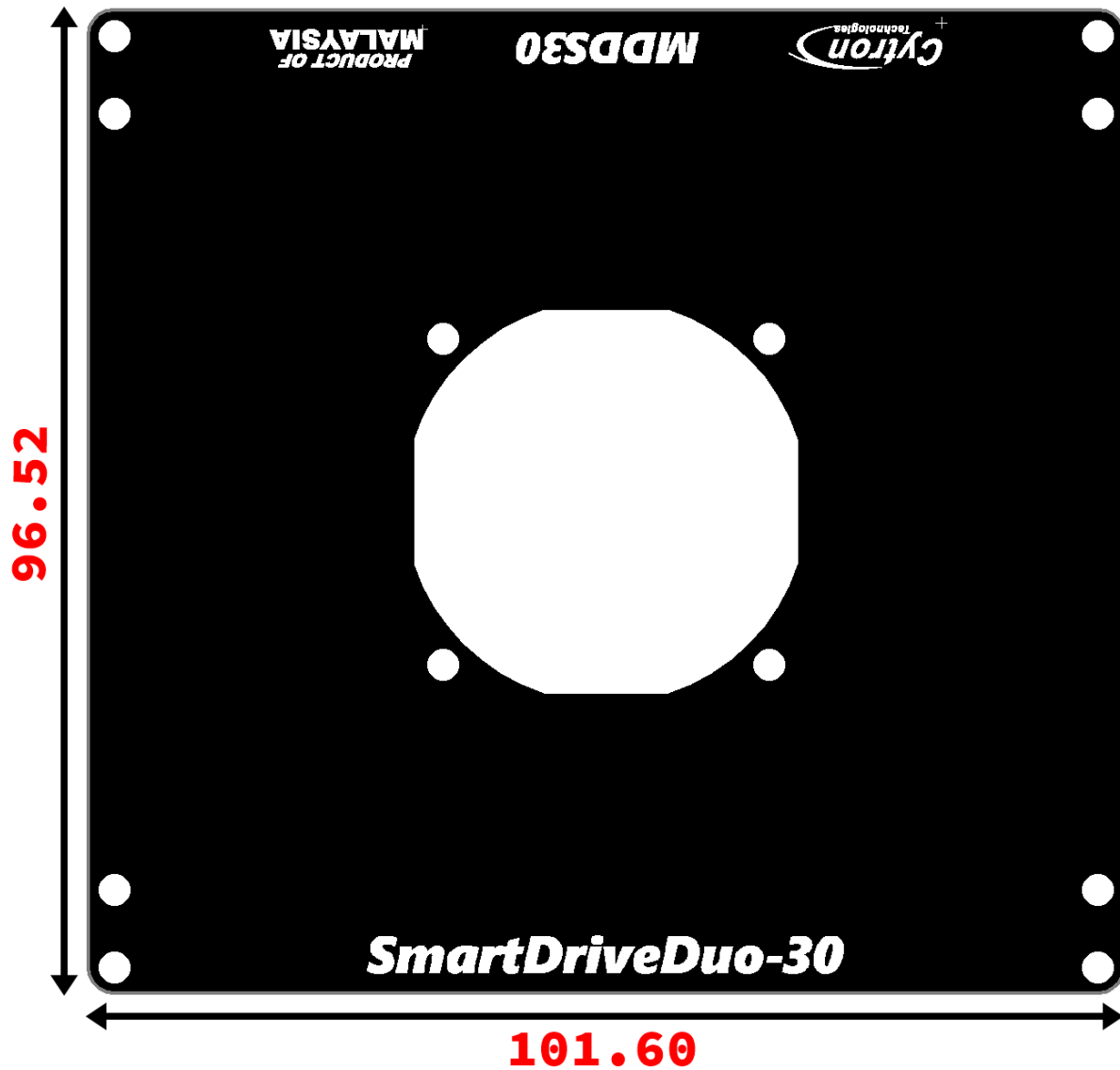
- MDDS30 main board.
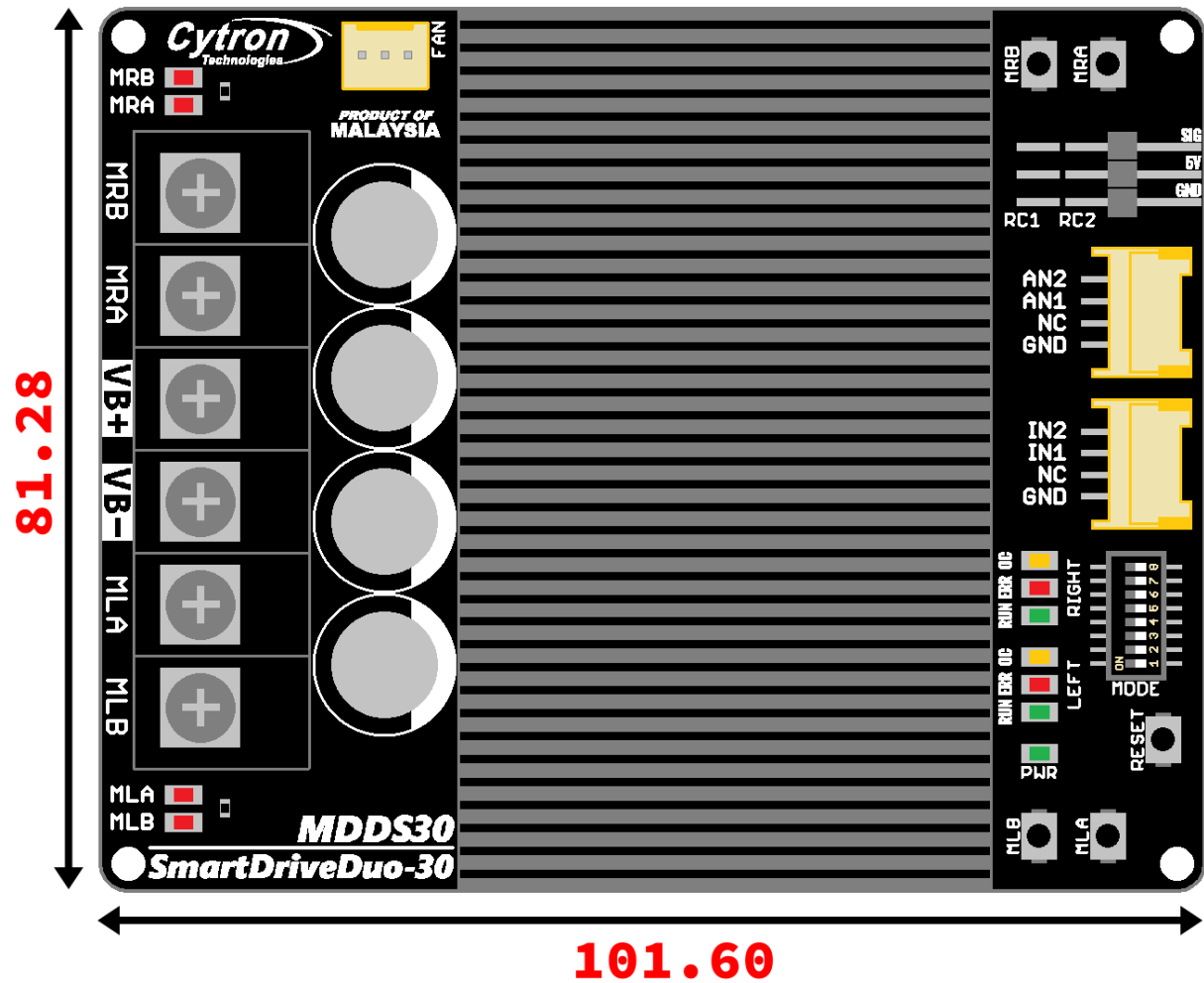
- MDDS30 height.

MDDS30 bottom cover:

Absolute Maximum Rating of SmartDriveDuo-30:

No	PARAMETERS	Min	Typ	Max	Unit
1	Input Voltage (Motor Supply Voltage)	7	–	**35**	V
2	I_{MAX} (Max Continuous Motor Current)*	–	–	**30**	A
3	I_{PEAK} (Peak Motor Current)**	–	–	**80**	A
4	V_{IOH} (Logic Input – HIGH Level)	1.3	–	5	V
5	V_{IOL} (Logic Input – LOW Level)	0	–	0.7	V

Depends on the room temperature.
**Must not exceed 1 second.*

4. BOARD LAYOUT
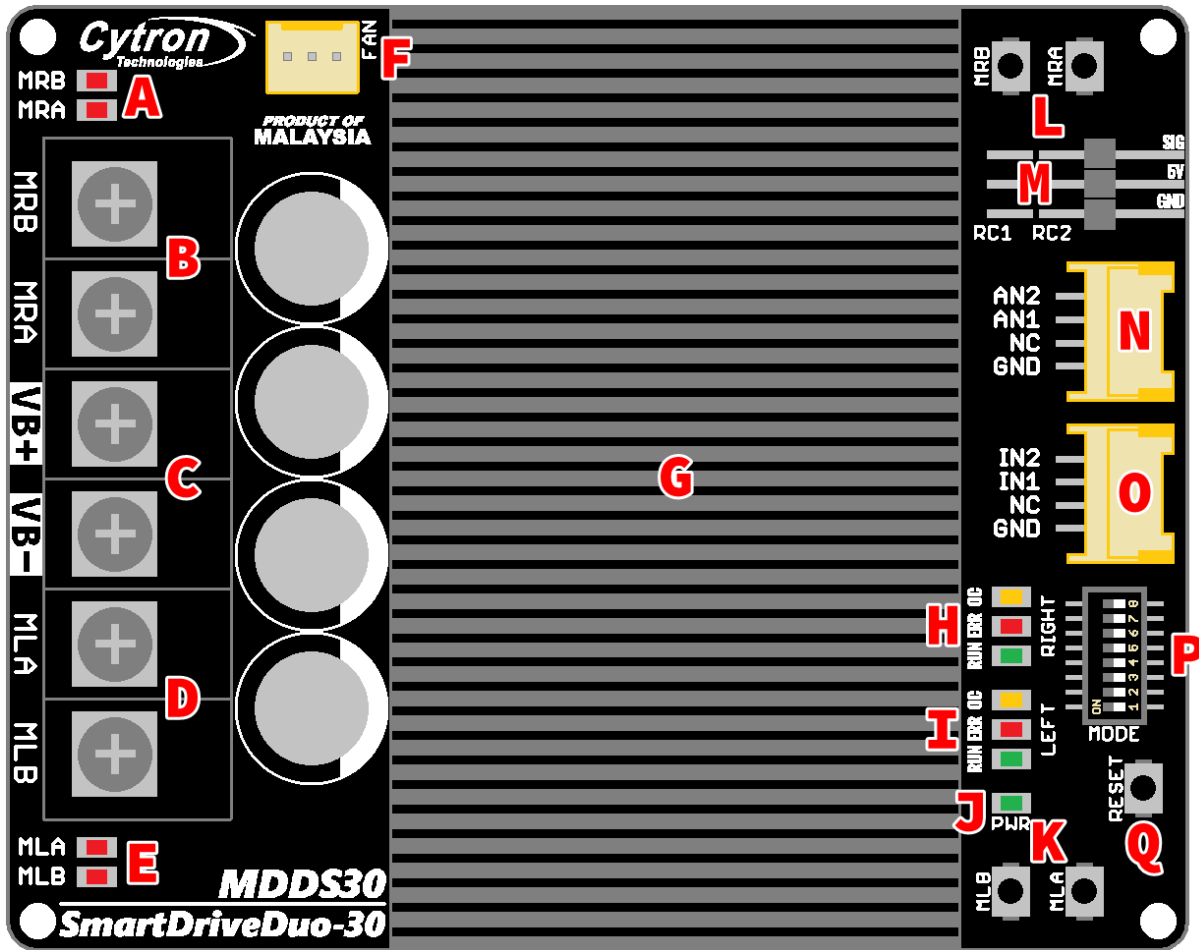
LABEL	FUNCTION
A	**MOTOR RIGHT LED INDICATOR** Indication for current flow and direction for motor RIGHT. If LED MRA turns on, means current flows from output MRA to MRB. Vice versa.
B	**MOTOR RIGHT TERMINAL BLOCK** Connect to motor RIGHT at your mobile robot. User can screw to lock the wire to the terminal block. Please use wire with proper thickness to support the expected current.
C	**POWER SUPPLY TERMINAL BLOCK** Connect to battery power source. User can screw to lock the wire to the terminal block. **NO POLARITY PROTECTION**, please double check the connection before power up. Please use wire with proper thickness to support the expected current.
D	**MOTOR LEFT TERMINAL BLOCK** Connect to motor LEFT at your mobile robot. User can screw to lock the wire to the terminal block or solder the wire directly to the pad at the bottom layer. Please use wire with proper thickness to support the expected current.
E	**MOTOR LEFT LED INDICATOR** Indication for current flow and direction for motor LEFT. If LED MLA turns on, means current flows from output MLA to MLB. Vice versa.
F	**COOLING FAN CONNECTOR** Optional cooling fan (not included) can be connected here and mounted at the bottom PCB. Pin

		arrangement from left to right are as follows: NC, +ve (5V), -ve. The fan will be automatically ON when the board's temperature exceeds 50°C.
G		**HEAT SINK** This area might be hot, please be careful.
H		**RIGHT CHANNEL LED INDICATOR** **RUN** - *Turns on when motor RIGHT is running. If signal error received for motor RIGHT, it will blink.* **ERR** - *Blinks at specific count if there have an error.* **OC** - *Light up if overcurrent happened.*
I		**LEFT CHANNEL LED INDICATOR** **RUN** - *Turns on when motor LEFT is running. If signal error received for motor LEFT, it will blink.* **ERR** - *Blinks at specific count if there have an error.* **OC** - *Light up if overcurrent happened.*
J		**POWER LED INDICATOR** Indication for board's power.
K		**MOTOR LEFT TEST BUTTON** Fast test to check driver functionality for motor LEFT. If MLA is pressed, current flows from output MLA to MLB. Vice Versa.
L		**MOTOR RIGHT TEST BUTTON** Fast test to check driver functionality for motor RIGHT. If MRA is pressed, current flows from output MRA to MRB. Vice Versa.
M		**RC INPUT PIN** This pins specially for RC receiver input wire. RC1 for forward/reverse and RC2 for steering.
N		**ANALOG/PWM INPUT PIN (GROVE)** **AN1** - Analog/PWM signal for motor LEFT. **AN2** - Analog/PWM signal for motor RIGHT. **NC** - Not Connected
O		**DIGITAL/SERIAL INPUT PIN (GROVE)** **IN1** - Digital signal (direction) for motor LEFT, or can be used for Serial mode. **IN2** - Digital signal (direction) for motor RIGHT. **NC** - Not Connected
P		**MODE SELECTION DIP SWITCH** User can select different input mode by setting the DIP switch.
Q		**RESET BUTTON** Press this button will restart the system. This is useful if you want to change mode without recycle power (turn off and on).

5. POWER SUPPLY

SmartDriveDuo-30 supports battery with input voltage ranges from 7V to 35V. The recommended power sources are:

- 6 – 18 cells NiMH or NiCd battery.
- 3 – 6 cells LiPo or Li-Ion battery.
- 7V – 35V sealed lead acid battery.
- 7V – 35V power supply. **MUST BE IN PARALLEL WITH A BATTERY WITH SAME VOLTAGE**

The power source can be connected to SmartDriveDuo-30 either via the terminal block, or soldered directly to the pad at the bottom layer. **THERE IS NO POLARITY PROTECTION ON MDDS30, PLEASE DOUBLE CHECK THE CONNECTION BEFORE CONNECTING TO THE BATTERY.**

NOTE
If a power supply that cannot sink current is being used (example: bench top and AC to DC switching power supply), the input voltage will rise when the driver is regenerating (motor is slowing down, or being pushed by external force). Thus, it is important to connect a battery with same voltage in parallel with the power supply to absorb the current generated by the motor. Else, the input voltage might rise to a level where SmartDriveDuo-30 can't handle and it will be destroyed permanently or the power supply trigger protection mode.

6. MOTOR CONNECTION

Similar to the power supply, connection to the motor can be made either via the terminal block, or it can be soldered directly to the bottom layer pad.

For MIXED mode, especially for **RC input mode**, each terminal block must be connected to the same side of the motor. For example, left terminal block connected to motor LEFT and right terminal block connected to motor RIGHT. User can further test it by controlling the motor by using RC controller. If the motor give wrong direction, reverse the polarity of the motor connection at the terminal block.

<div style="border:2px solid red; padding:10px;">

<div style="background:red; color:white; text-align:center;">

WARNING!

</div>

IF YOU'RE DEVELOPING A MOBILE ROBOT, PLEASE TAKE NOTE ON THIS:
*Pushing the robot without connecting the batteries to the driver is very risky and might burn the motor driver. When the robot is being pushed, power will be generated by the motor. If the battery is connected, the generated power will flow to the battery and charge it. **If the battery is not connected, the generated power has nowhere to go and the voltage will rise. If the generated voltage is higher than what the motor driver can handle, components may burn!***

This condition is categorized under misuse, and
DAMAGED CAUSED BY MISUSE IS NOT COVERED UNDER WARRANTY

What you can do to move your robot from one place to another?
1. *If you plan to push/pull the robot, please make sure the batteries is connected to the motor driver* or*
2. *disconnect the motor from the motor driver.*
3. *Use trolley to carry your robot. (Recommended)*

</div>

*You will feel difficult to push the robot, because the motor driver is in brake state.

7. SAFETY FEATURES

SmartDriveDuo-30 incorporates some safety features which make it robust and reliable motor driver. Below are the detailed descriptions for each feature.

1. **Input Error** (**Error LED** blinks **2** times)
   Every time SmartDriveDuo-30 is power up, the input data must be 'stop' (for RC, Analog, PWM input mode). This feature prevent the driver from sudden run, especially when the driver accidently reset.

2. **Under Voltage Warning** (**Error LED** blinks **3** times)
   Upon power on, SmartDriveDuo-30 will automatically detect the number of cells for the battery. If it is set to LiPo, when the input voltage falls below 3.0V per cell during operation, the error LED will blink to warn the user. However, the power to the motor will be maintained and will not be cut out. Thus, it is user's responsibility to stop the motor driving and replace battery to avoid further damage to the battery. If other types of battery is used to power the board (e.g NiMH, NiCD, SLA), the under voltage warning will still be shown. In this case, user may ignore the warning and he/she needs to estimate when to replace the battery by him/herself.

3. **Over Voltage Protection** (**Error LED** blinks **4** times)
   If over voltage is detected (> 35V), SmartDriveDuo-30 will not operate.

4. **Over Temperature Protection** (**Error LED** blinks **5** times)
   SmartDriveDuo-30 is equipped with a temperature sensor to monitor its operating temperature. It will gradually lower down the duty cycle percentage base on the temperature as shown below:

TEMPERATURE (°C)	MAX CURRENT (A)
< 50	80
50 - 70	50
70 - 100	40
> 100	30

WARNING!
MDDS30 does not come with REVERSE POLARITY PROTECTION, please double check the connection before powering up.

8. INPUT MODES

When the SmartDriveDuo-30 is powered up, RUN (Left), ERR (Left), RUN (Right) and ERR (Right) LEDs will running once. After that, the input mode will be read from the DIP switch and retained as long as the driver is powered. If you wish to change the input mode, you will need to change the setting on the DIP switch and press the RESET button, or power cycle the driver (turn it off and turn it on again).

<table>
<tr><td>NOTE</td></tr>
<tr><td><i>In Jan 2019, MDDS30 is released as Rev1.10. The firmware is updated. Please check section 8.1 RC (Radio Controlled) for the detailed update. There is Revision sticker on MDDS30 Rev1.10 as shown below.</i></td></tr>
</table>

MDDS30 Rev1.00 — Side View — MDDS30 Rev1.10

MDDS30 Rev1.00 — Bottom View — MDDS30 Rev1.10

SmartDriveDuo-30 supports four different types of input mode:
1. RC (Radio Control).
2. Microcontroller Analog/PWM.
3. Serial Simplified.
4. Serial Packetized.

The DIP switch settings for each mode and the function for input pin are summarized on the table below.

DIP Switch	1	2	3	4	5	6
RC	0	0	**CHANNEL** 00 - Mixed 01 - Independent Right 10 - Independent Left 11 - Independent Both	0 - Linear 1 - Exponential	0 - RC 1 - MCU
Analog	0	1			0 - Locked Anti-Phase 1 - Signed Magnitude
PWM	1	0			
Serial Simplified	1	1	0	**BAUDRATE** 000 - 1200 100 - 19200 001 - 2400 101 - 38400 010 - 4800 110 - 57600 011 - 9600 111 - 115200		
Serial Packetized	1	1	1	**ADDRESS** Start from 000 (Decimal: 0) to 111 (Decimal: 7)		

DIP Switch	7	8
RC	**BATTERY MONITOR** 00 - LiPo (Lithium Polymer) 01 - NiMH (Nickel-Metal Hydride) 10 - SLA (Sealed Lead Acid) 11 - Off	
Analog		
PWM		
Serial Simplified		
Serial Packetized		

8.1 RC (Radio Controlled)

In RC input mode, the speed and direction of the motor is controlled by the signal from the standard hobby radio control transmitter and receiver, or a microcontroller generating the similar signal.

NOTE
The RC transmitter must be ON before power up the SmartDriveDuo-30.

RC Input mode is selected by setting the SW1 & SW2 to 0 (Down). SW3 – SW6 can be configured depending on the requirement of the user.

Input Mode	SW1:SW2 00	RC INPUT MODE
Single or Mixed Mode	SW3:SW4 00	**MIXED** The motor speed is controlled by channel RC1 and direction is controlled by channel RC2. Recommended this mode if controlled using RC transmitter/receiver.
	01	**INDEPENDENT RIGHT** Only motor Right will active, motor Left will inactive. Motor Right is controlled by channel RC2.
	10	**INDEPENDENT LEFT** Only motor Left will active, motor Right will inactive. Motor Left is controlled by channel RC1.
	11	**INDEPENDENT BOTH** Both motor is active and can be controlled individually through channel RC1 and RC2. Recommended this mode if controlled using Microcontroller.
Exponential Mode	SW5 0	**OFF** The speed is linear with the input signal. This is for low to medium speed motor.
	1	**ON** The response to input is exponential and thus soften the control around the center zero speed point. This is suitable for high speed and very sensitive motor.
MCU Mode (Rev 1.00)	SW6 0	**OFF** The center point will be calibrated upon power up. Timeout occurs after lost of signal for 100ms and the motor will be stopped for safety purpose.

	1	**ON** The center point is fixed at 1.5ms and the timeout feature is disabled. Motor will continue to run with previous speed if new signal is not detected. This is useful when a microcontroller is used to control the motor. The microcontroller does not need to send the pulse continuously to the SmartDriveDuo-30. Instead, it only needs to send a single pulse when the speed or direction of the motor needs to be changed.
Full Range Mode **(Rev 1.10)** *Replacing MCU mode in Rev 1.00*	**SW6** 0	**OFF** The max speed of the motor will be reached at around half of the throttle. Let say the center of throttle is 1.5ms, and max for both sides are 1ms and 2ms. The max speed can be achieved at 1.25ms and 1.75ms respectively. This will provide faster response to motor in combat game and it is the default mode in Rev1.00.
	1	**ON** The max speed of the motor will be reached at full of throttle. Let say the center of throttle is 1.5ms, and max for both sides are 1ms and 2ms. The max speed can be achieved at 1ms and 2ms respectively. This is additional mode (replacing MCU mode) in **revision 1.10**.

0 - OFF   1 - ON   X - Don't care

Common DIP switch settings for RC input mode
● RC Mode with RC transmitter/receiver (Mixed)
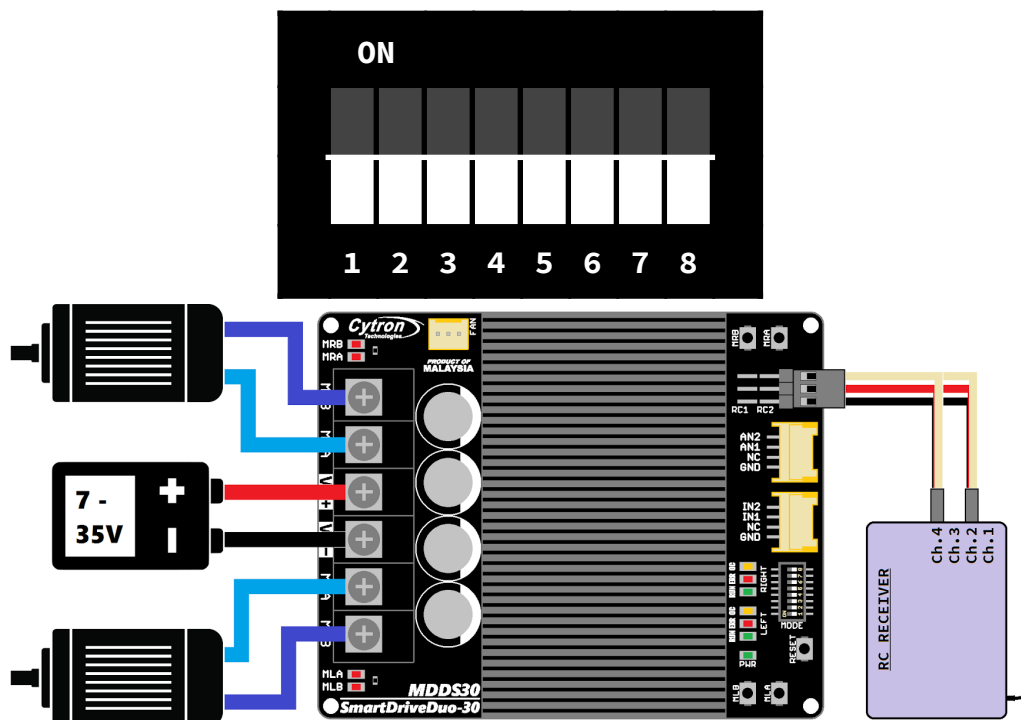
*Sample connection for MDDS30 with RC receiver. The channels on RC receiver is depend on your RC controller's setting.

8.2 Microcontroller Analog/PWM

In Analog/PWM input mode, the speed and direction of the motor is controlled by the analog voltage or PWM signal. For analog, the valid input range is from 0 to 5V. While for PWM, it can accept TTL PWM from 1.3 to 5V for HIGH level (refer to Product Specifications).

NOTE
The Analog/PWM signal to stop the motor must be available when SmartDriveDuo-30 is turned on/reset. Else, the driver will show Input Error until the correct (stop) signal is available.

Stop signal for Analog	Stop signal for PWM
*Sign-Magnitude - **0V***	*Sign-Magnitude - **0%** duty cycle*
*Locked Anti-Phase - **2.5V***	*Locked Anti-Phase - **50%** duty cycle*

Analog input mode is selected by setting SW1 to 0 (Down) and SW2 to 1 (Up). PWM input mode is selected by setting SW1 to 1 (Up) and SW2 to 0 (Down). SW3 – SW6 can be configured depending on the requirement of the user.

	SW1:SW2	
Input Mode	01	**ANALOG INPUT MODE** The input is analog signal. The filter capacitor is not connected and the input signal is not filtered. SW1 is for Input 1 while SW2 is for Input 2.
	10	**PWM INPUT MODE** The input is PWM signal. The filter capacitor is connected and the input signal is low pass filtered to be an analog signal. SW1 is for Input 1 while SW2 is for Input 2. SW2 must be set to 0 if Sign-Magnitude mode is turned on.
	SW3:SW4	
Single or Mixed Mode	00	**MIXED** The motor speed is controlled by channel AN1 and direction is controlled by channel AN2.
	01	**INDEPENDENT RIGHT** Only motor Right will active, motor Left will inactive. Motor Right is controlled by channel IN2 and AN2.
	10	**INDEPENDENT LEFT** Only motor Left will active, motor Right will inactive. Motor Left is controlled by channel IN1 and AN1.
	11	**INDEPENDENT BOTH** Both motor is active and can be controlled individually through channel IN1 & AN1 for motor Left, and IN2 & AN2 for motor Right.
	SW5	
Exponential Mode	0	**OFF** The speed is linear with the input signal. This is for low to medium speed motor.

	1	**ON** The response to input is exponential and thus soften the control around the center zero speed point. This is suitable for high speed and very sensitive motor.
MCU Mode	**SW6** 0	**LOCKED ANTI-PHASE** Motor stops when the input signal is 2.5V. Motor moves in one direction when the input is < 2.5V (0 - 2.5V) and in another direction when the input is > 2.5V (2.5 - 5V).
	1	**SIGNED MAGNITUDE** AN1 and AN2 controls the speed of the motor. Motor stops when the input is 0V and run at full speed when the input is 5V. IN1 and IN2 is digital inputs and it controls the direction of the motor respectively.

0 - OFF   1 - ON   X - Don't care

Common DIP switch settings for PWM input mode
- PWM input mode with microcontroller (Independent Both)
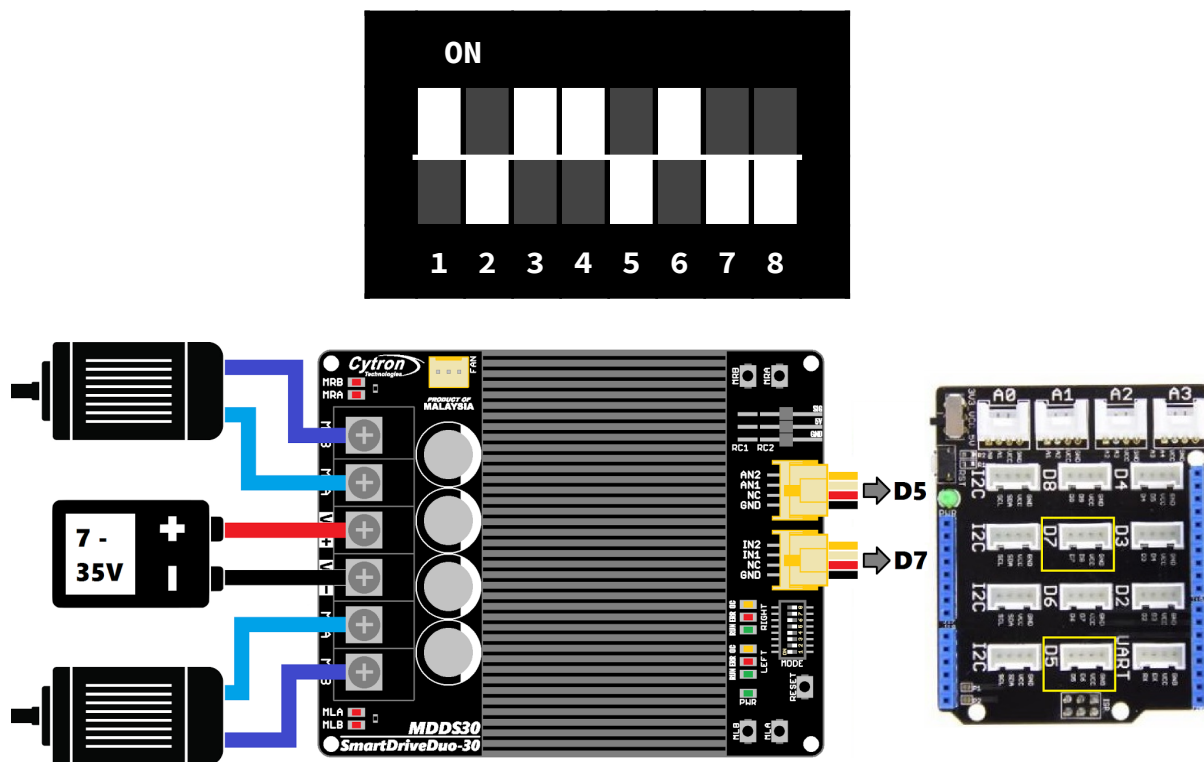
*Sample connection for MDDS30 with CT UNO (or Arduino/Genuino Uno) and Base Shield V2. This connection is recommended for beginner.
**Arduino Uno library and sample code is provided at the following link - GitHub.

8.3 Serial Simplified

In Serial Simplified mode, SmartDriveDuo-30 is controlled by using the UART interface. IN1 pin is connected to the UART receive pin. IN2, AN1 and AN2 pins are not used in this mode.

Serial Simplified mode is selected by setting SW1, SW2 to 1 (Up) and SW3 to 0 (Down). SW4 – SW6 can be configured depending on the requirement of the user.

Input Mode	SW1-SW3 110	SERIAL SIMPLIFIED MODE
UART Baudrate	SW4-SW6 000 001 010 011 100 101 110 111	1200 2400 4800 9600 19200 38400 57600 115200

0 - OFF   1 - ON   X - Don't care

A single byte of data is all you need to control the speed and direction for each motor. First MSB bit is to select which motor to control, and the rest bits is to control.

BIT	7_{MSB}	6	5	4	3	2	1	0_{LSB}
FUNCTION	Channel	Direction	Speed					

Bit 7 (Channel):
- **0** for selecting motor LEFT.
- **1** for selecting motor RIGHT.

Bit 6 (Direction):
- **0** to set motor direction to CW.
- **1** to set motor direction to CCW.

Bit 0 - 5 (Speed):
- 0b**000000** or **0** (decimal) to stop.
- 0b**111111** or **63** (decimal) to full speed.

Example Serial Simplified data:

	Binary bits								Decimal	
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**		
1.	0	0	0	0	0	0	0	0	0	motor LEFT stop.
2.	0	0	1	1	1	1	1	1	63	motor LEFT full speed CW.
3.	0	1	0	0	0	0	0	0	64	motor LEFT stop.
4.	0	1	1	1	1	1	1	1	127	motor LEFT full speed CCW.
5.	1	0	0	0	0	0	0	0	128	motor RIGHT stop.
6.	1	0	1	1	1	1	1	1	191	motor RIGHT full speed CW.
7.	1	1	0	0	0	0	0	0	192	motor RIGHT stop.
8.	1	1	1	1	1	1	1	1	255	motor RIGHT full speed CCW.

Common DIP switch settings for Serial Simplified mode
- Serial Simplified mode with microcontroller (Baudrate: 9600bps)
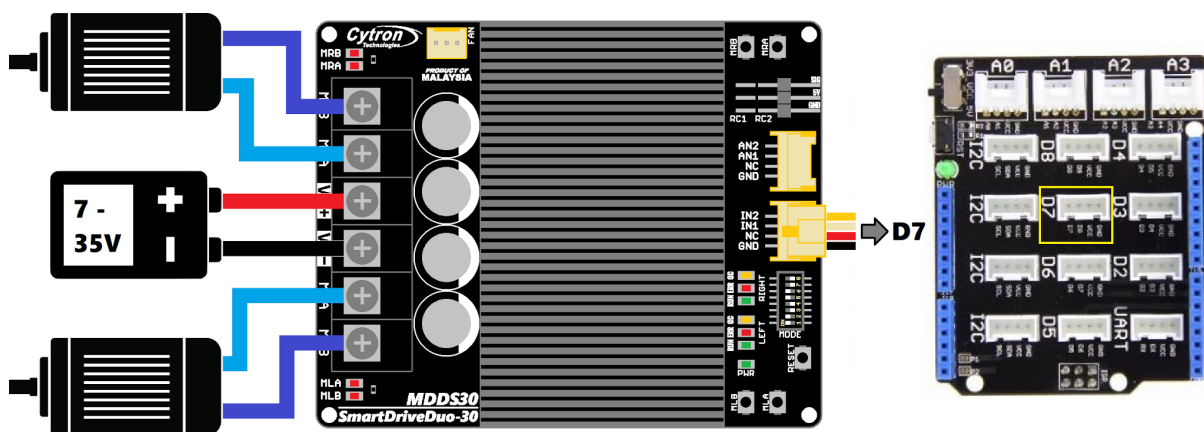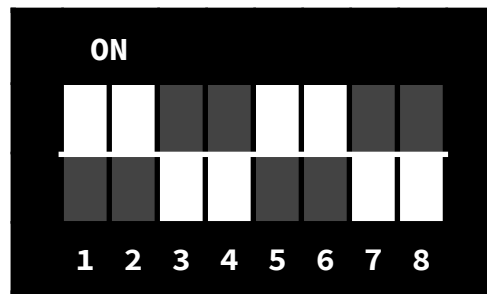
*Sample connection for MDDS30 with CT UNO (or Arduino/Genuino Uno) and Base Shield V2. This connection is recommended for beginner.
**Arduino Uno sample code is provided at the following link - GitHub.

8.4 Serial Packetized

In Serial Packetized mode, SmartDriveDuo-30 is controlled by using the UART interface. IN1 pin is connected to the UART receive pin. IN2, AN1 and AN2 pins are not used in this mode. To control the motor, data sent to the driver must be in 4 bytes packet format which includes a header, address, command and checksum. Up to 8 units of SmartDriveDuo-30 can be connected together to a single microcontroller UART Tx pin.

Besides that, the SmartDriveDuo-30 also incorporates an auto-baudrate feature in this mode. When the driver is powered up, the host microcontroller must send a dummy byte (Decimal **128** or Hex **0x80**) once to the driver. The driver will then calculate the baudrate automatically based on this byte. After that, SmartDriveDuo-30 is ready to read full packet (4 bytes) and the baudrate cannot be changed without power recycle (power off and on) or reset button.

NOTE
When the driver is powered up and waiting for the header byte, the error LED will blink and indicate that there is input error.
SmartDriveDuo-30 may take up to 500ms to start up after power is applied. Sending a dummy byte for auto-baudrate during this period may cause undesirable results. Please allow one-second delay between applying power and sending a dummy byte.
Minimum and maximum baudrate for autobaud is 4800 bps and 115200 bps.

Packetized Serial mode is selected by setting SW1, SW2 and SW3 to 1 (Up). SW4 – SW6 are used to select the address.

Input Mode	**SW1-SW3** 111	**SERIAL PACKETIZED MODE**
UART Address	**SW4-SW6** 000 001 010 011 100 101 110 111	Address: **0** Address: **1** Address: **2** Address: **3** Address: **4** Address: **5** Address: **6** Address: **7**

0 - OFF   1 - ON   X - Don't care

A packet consists of 4 bytes and the format is shown in the following table.

BYTE	NAME	VALUE (Decimal)	DESCRIPTION
1	Header	0x55 (85)	To indicate the start of packet.
2	Channel & Address	Channel: Bit 3 Address: Bit 0 - 2	Used to identify the driver when multiple units are connected together. The Address bits (bit 2 - 0) must match the address configured with the DIP switch. Bit 3 represent which motor to be controlled (0 for motor LEFT and 1 for motor RIGHT). Bit 4 - 7 is not used.
3	Command	0 - 255	Value 127 stops the motor, 0 is full reverse and 255 is full forward.
4	Checksum	0 - 255	The value for checksum must be the result of Header + Address + Command.

Common DIP switch settings for Serial Packetized mode
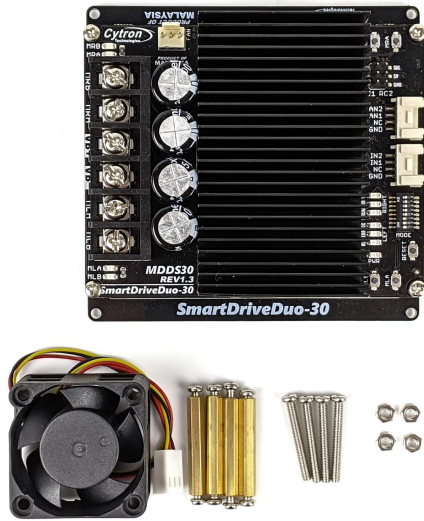● Serial Packetized mode with microcontroller (Address: 0)
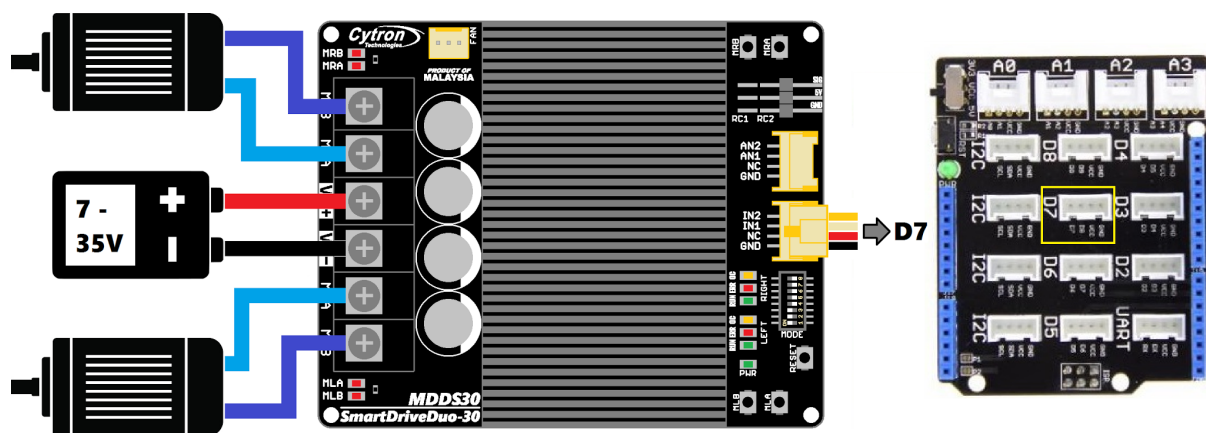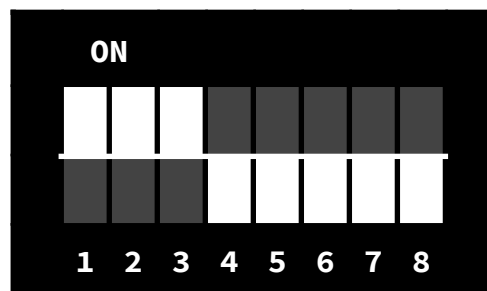
*Sample connection for MDDS30 with CT UNO (or Arduino/Genuino Uno) and Base Shield V2. This connection is recommended for beginner.
**Arduino Uno sample code is provided at the following link - GitHub.

9. Assemble Optional Fan

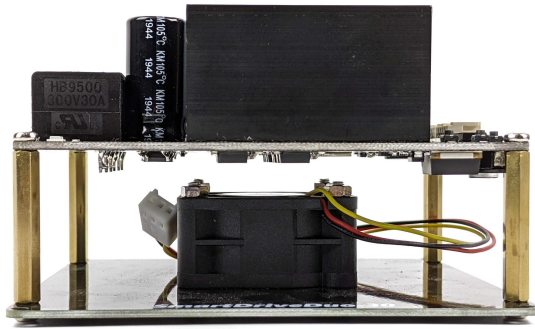1. Prepare the optional accessories to mount the cooling fan.

2. Unscrew the four PCB standoffs and separate the top and bottom PCB.
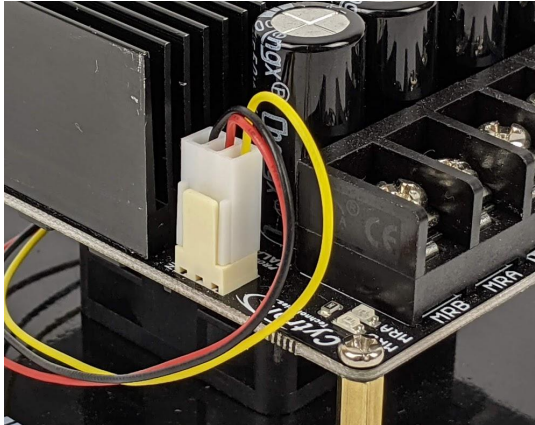

3. Mount the fan to the inner side of the bottom layer PCB using screws and nuts. Make sure the airflow direction is correct.
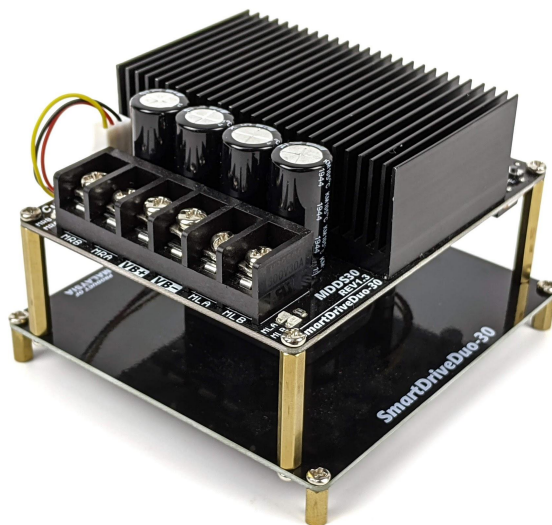
4. Assemble back the top and bottom PCB using the longer PCB standoffs.

5. Connect the fan to the fan connector.

6. Use the original short PCB standoffs to mount the motor driver to your platform to allow some clearance between the platform and the fan intake.

7. Please take note that the fan will only turn on when the motor driver is getting hot.

10. WARRANTY

- Product warranty is valid for 12 months.
- Warranty only applies to manufacturing defect.
- Damaged caused by misuse is not covered under warranty.
- Warranty does not cover freight cost for both ways.

Prepared by:

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