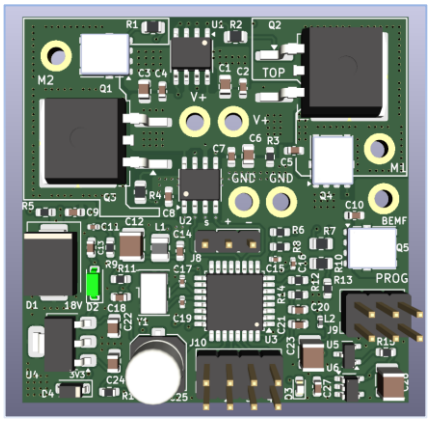
What	Item	Value	Unit	Remark
Specs	Supply voltage	5-15	V	V+
	Supply type	Battery		NiMH, Lithium/LiPo, Lead Acid (also rechargeable)
	Hardware low voltage det.	4	V	Under voltage lock out H-bridge driver IC
	Motor current	15 & 30	A	Respectively nominal and peak (peak max 10 seconds)
	BEMF current	5	A	Max continue
	External back EMF resistor[1]	?	Ω	To be determined empirical (if needed)
	Ambient temperature	0-50	°C	
	Motor type	DC brushed		
	Control	Proportional		Servo pulse
	Directions	CW/CCW		
	Dimensions	47x47x10	mm	Without capacitor at the back
	Number of motors	1		Propeller, pistons tanks, pumps etc.
	Thermal losses H-bridge	3.5 + 0.5	W	P-ch + N-ch MOSFET
	PCB cooling area	833 + 765	mm^2	Respectively M1 and M2 (bottom and top side PCB)
	Visual feedback	green		Status LED
NOT included **NOT Supported** **Does NOT have**	**Motor filter**			**See mandatory**
	Reverse polarity protection			**Limited (only 3.3V circuitry, not the H-bridge & MOSFET drivers)**
	Over voltage protection[2]			**Limited (TVS only, consider using a back EMF resistor)**
	Over temperature protection			**Left out (better an overheated ESC than a sunken model submarine)**
	Short circuit protection			**Consider installing a fuse in series with the V+ wire.**
	Motor over current shut off			**Left out for maximum operational reliability.**
	On board fuse V+			**Consider installing a fuse in series with the V+ wire.**
	Strong dynamic braking			**H-bridge shorting motor terminals (fast motor stop)**
	Heatsink			**Designed to operate without**
	Low battery detection			**Only hardware under voltage lock out at 4V (MOSFET driver IC)**
	Mounting holes			
	Audible feedback			
	Temperature protection external BEMF resistor			**Ensure the back EMF resistor(s) has enough wattage**
Options	Supply decoupling capacitor	1000	µF	Recommended, mounted on the back of the PCB (includes a discharge resistor on the PCB).
	External back EMF output			BEMF terminal, switches to GND (NPN)
	Shielded motor cable			Uses extra GND connection
	Heat shrink tubing	60 (width)	mm	As packaging/housing/electrical isolation
	Coating of the PCB	Plastic 70		To protect against moisture.
	Stackable (max 3)	Y		4x solid copper wire through V+ and GND holes (common decoupling capacitor at the back of one PCB
	Weak dynamic braking	165	Ω	4x 330 Ohm 2512 resistor on back of PCB (from M1 and M2 to GND)
Mandatory	Motor filter[3]			Attach directly to or close to the motor connections.
Jumpers	1 Dead band and hysteresis	5/2 or 10/4	%	No jumper = 5/2 (relative to PWM range of -100…+100%)
	2 PWM frequency	2 or 16	kHz	No jumper = 2kHz
	3 Length servo pulse	1.0-2.0 or 0.5-2.5	ms	No jumper = 1.0-2.0ms
	4 Transfer function	LIN/SQR[4]		No jumper = LIN (LIN = Linear, SQR = Square root)

BEMF terminal

If the supply voltage gets too high due to back EMF (e.g. motor acting as generator), the BEMF terminal switches to GND. When connecting an external power resistor between the V+ and the BEMF terminal, back EMF energy can be converted into heat.

There are two types of supply voltage measurements. One with slow averaging (20.0s) and one with fast averaging (0.2s). If the difference between both is more than 1V uninterrupted for 0.2s then the BEMF output is activated (10% hysteresis).

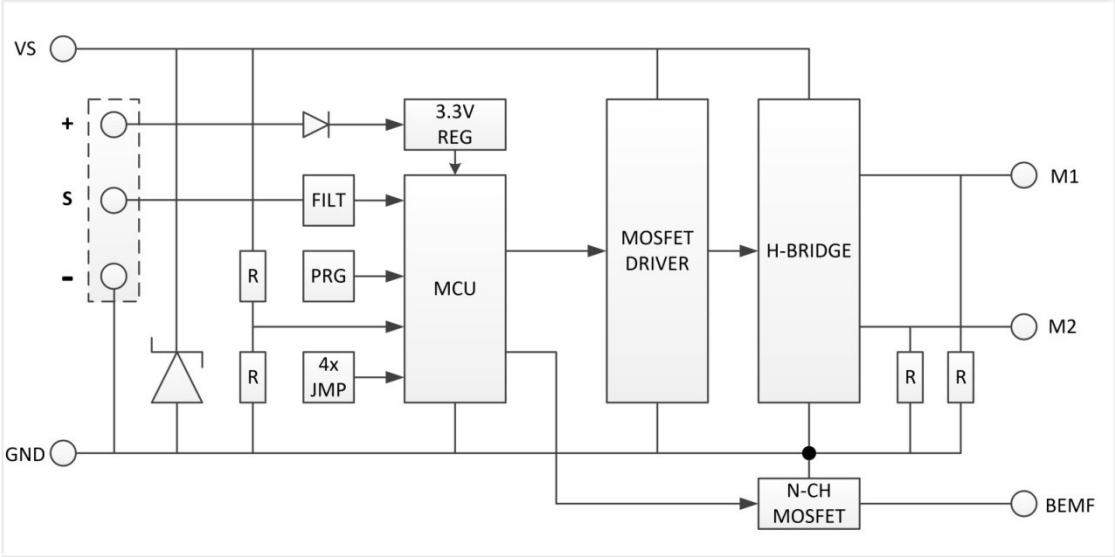
If no external back EMF resistor is used and D1 (18V TVS) gets hot during normal motor operation then most likely a BEMF resistor is needed.

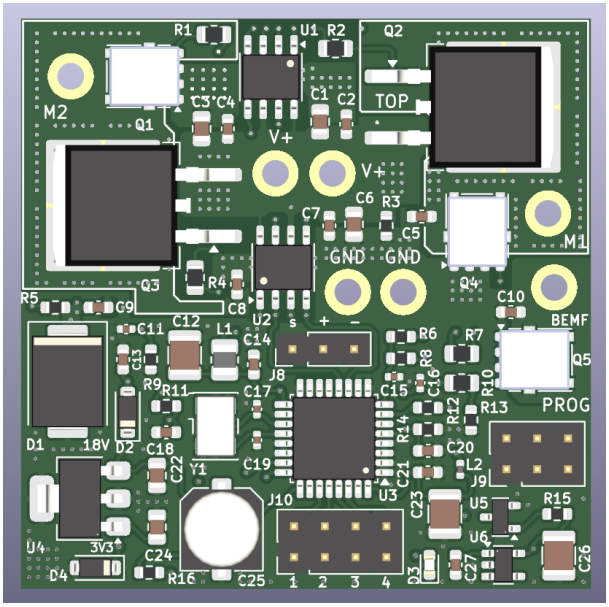


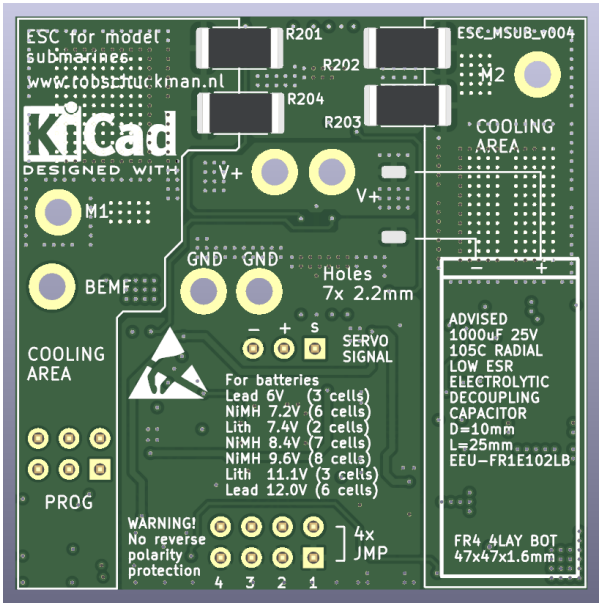
Notes

- At 2kHz PWM frequency, a soft whistling sound may come from the motor.
- On board status LED (on = PON[5] & no servo signal, flashing = PON & servo signal)

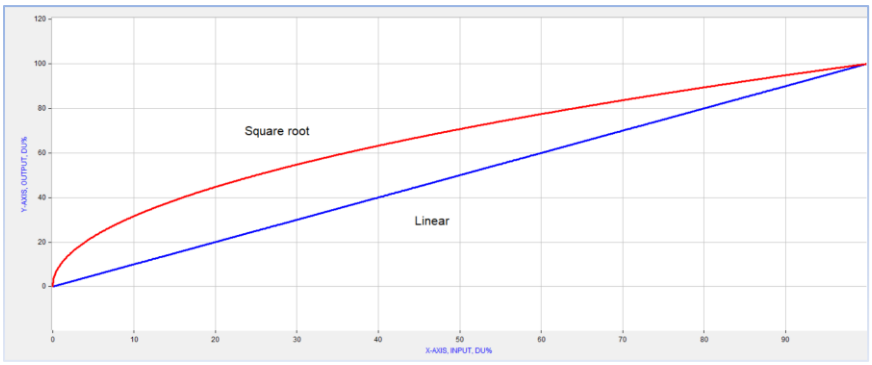
[1] Ensure the external back EMF resistor has enough wattage.
[2] 18V TVS connected parallel with H-bridge supply voltage.
[3] Consists of 2 inductors in series with motor wiring and 3 capacitor soldered directly on motor terminals and motor housing.
[4] Use the SQR transfer function for more linear joystick behaviour if the electric motor encounters a lot of resistance when turning
[5] Power on





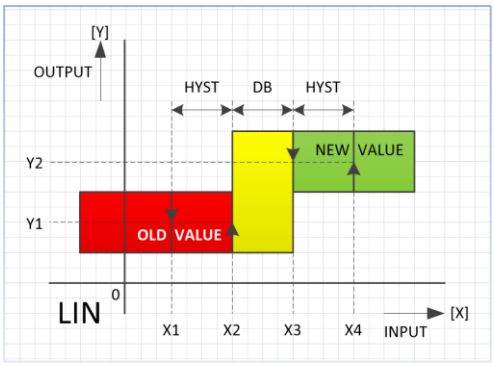


LIN/SQRT transfer function



X-axis = input = 0-100%, Y-axis = output = 0-100%

Hysteresis and dead-band



For Y to transfer from Y1 to Y2, (X4 - X2) > (DB + HYST)