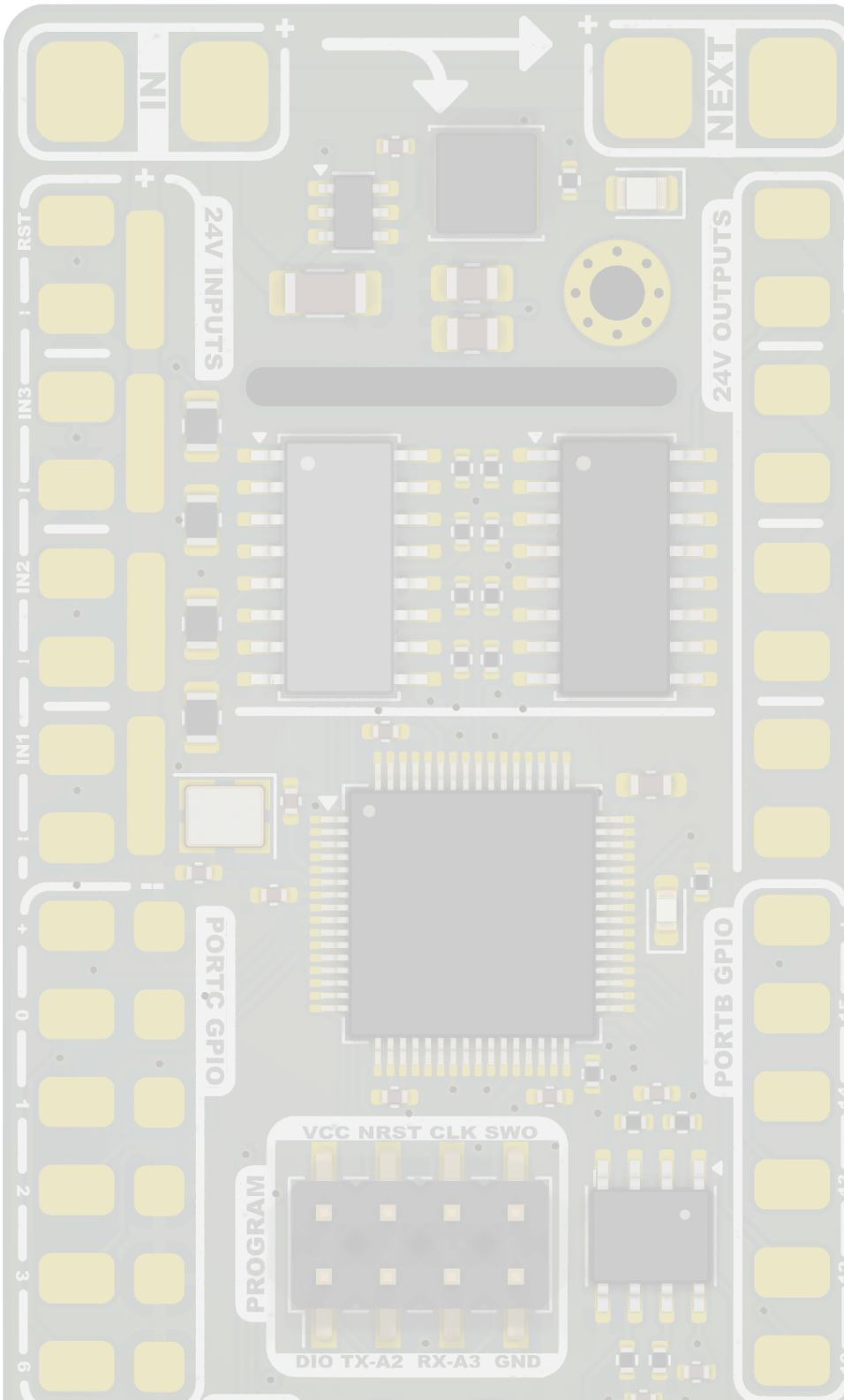
Board Guide : Motor Controller Powered by STM32F446RET6

Version 2, July 2025



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Key features

- STM32F446RET6 microcontroller (512 KB Flash, 128 KB RAM)
- 4-layer PCB (ENIG)
- Isolated RS3485 communication (MAX3485 transceiver)
- 24V to 3.3V buck converter (AP6303WU)
- 4 opto-isolated 24V digital inputs (TLP291)
- 4 opto-isolated low-side 24Vdigital outputs (TLP291)
- Hardware reset via 24V opto-isolated input
- 4-bit DIP switch for address selection (PA7, PB0–PB2)
- 16 MHz external crystal
- GPIO headers for user expansion (PORTB and PORTC)
- Status LED (PC9) and power LED for 3.3V indication

Board Pinout : GPIOs / Headers

PORTB GPIO Header (top to bottom)

Pin	STM32 pin	Function	Alternative Func
1	/	3.3 V	/
2	PB15	SPI2_MOSI	TIM12_CH2, USART1_RX
3	PB14	SPI2_MISO	TIM12_CH1, USART1_TX
4	PB13	SPI2_SCK	TIM1_CH1N
5	PB12	SPI2_NSS	TIM1_BKIN, I2C2_SMBA
6	PB10	GPIO	I2C2_SCL, TIM2_CH3, USART3_TX

PORTC GPIO Header (top to bottom)

Pin	STM32 pin	Function	Alternative Func
1	—	3.3 V	/
2	PC0	ADC10	FSMC
3	PC1	ADC11	FSMC
4	PC2	ADC12	FSMC
5	PC3	ADC13	FSMC
6	PC6	TIM3_CH1	USART6_TX

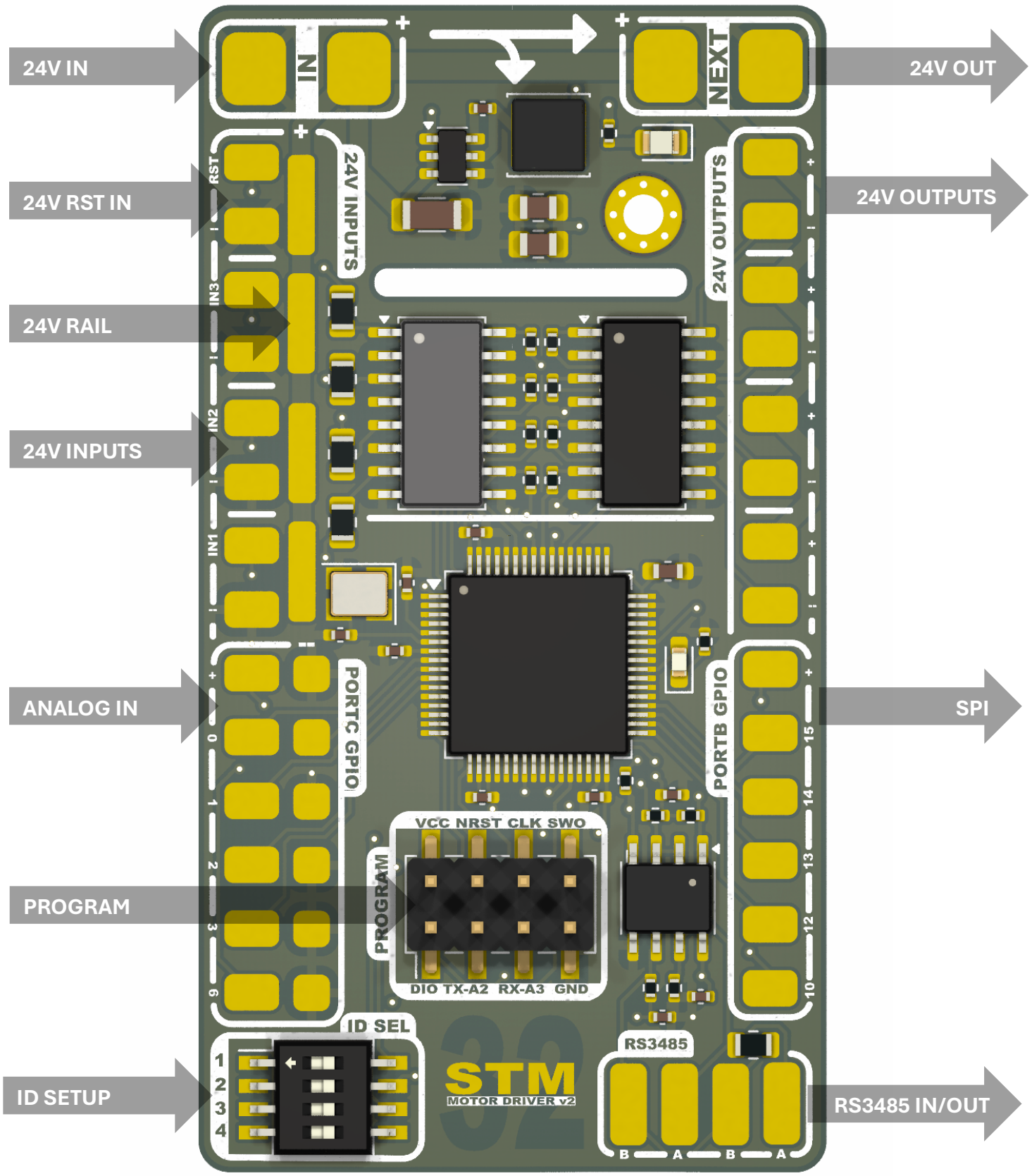
24V Inputs Header (top to bottom)

Pin	STM32 pin	Function	Alternative Func
1	RST	RESET	/
2	GND	GND	/
3	PB9	INPUT_3	/
4	GND	GND	/
5	PB8	INPUT_2	/
6	GND	GND	/
7	PB7	INPUT_1	/

24V Outputs Header (top to bottom)

Pin	STM32 pin	Function	Alternative Func
1	/	OUTPUT_1	24V
2	PB4	ACTIVE_GND	/
3	/	OUTPUT_2	24V
4	PB5	ACTIVE_GND	/
5	/	OUTPUT_3	24V
6	PD2	ACTIVE_GND	/
7	/	OUTPUT_4	24V
8	PC12	ACTIVE_GND	/

Board Pinout : Visualization



Programming Header

Header Pinout:

Pin	Signal	Description
1	3.3V	Power reference
2	NRST	Hardware reset input
3	SWCLK	SWD clock
4	SWO	Optional SWD output trace
5	SWDIO	SWD data line
6	PA2	UART TX (from STM32)
7	PA3	UART RX (to STM32)
8	GND	Ground reference

3.3V pin is only for voltage reference!

The board includes a dedicated 8-pin programming and debugging header that provides full access to both SWD (Serial Wire Debug) and UART interfaces for firmware flashing and runtime communication/debugging using standard STM32 tools.

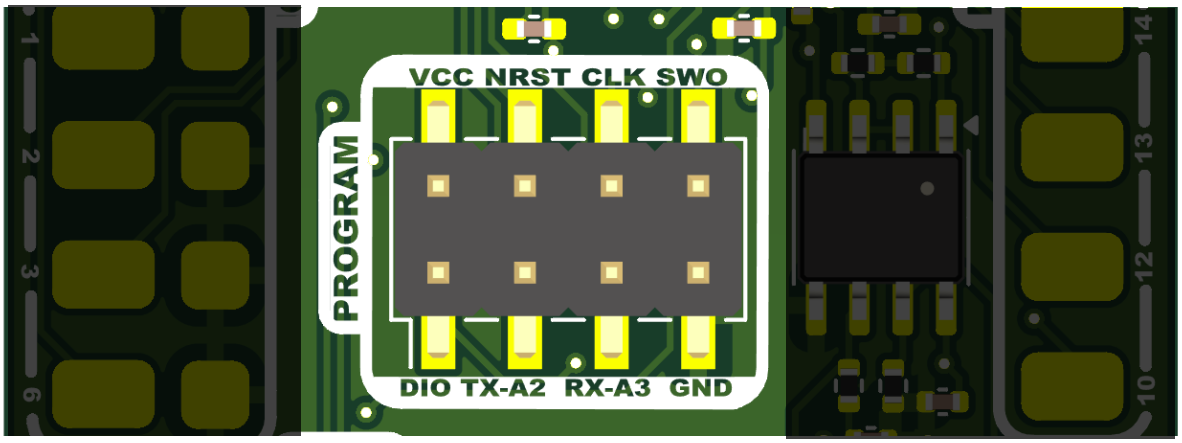
Supported use cases :

- Flashing firmware via SWD using tools like ST-Link, J-Link, or CMSIS-DAP

- Debugging with breakpoints, memory watch, and variable inspection via STM32CubeIDE or GDB

- UART bootloader access via PA2/PA3 using USB-to-Serial adapter (for STM32 ROM bootloader)

- Console-style communication with firmware (e.g. printf debugging, shell interfaces)

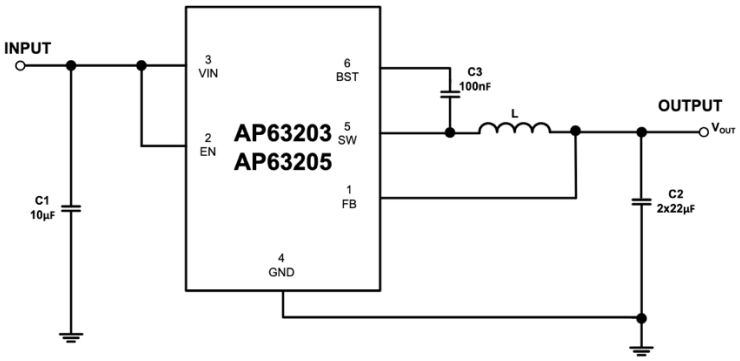


Power Supply

The board features an integrated step-down power converter based on the **AP63203WU**, a 2 A synchronous buck regulator. It accepts input voltages from 8 V to 32 V.

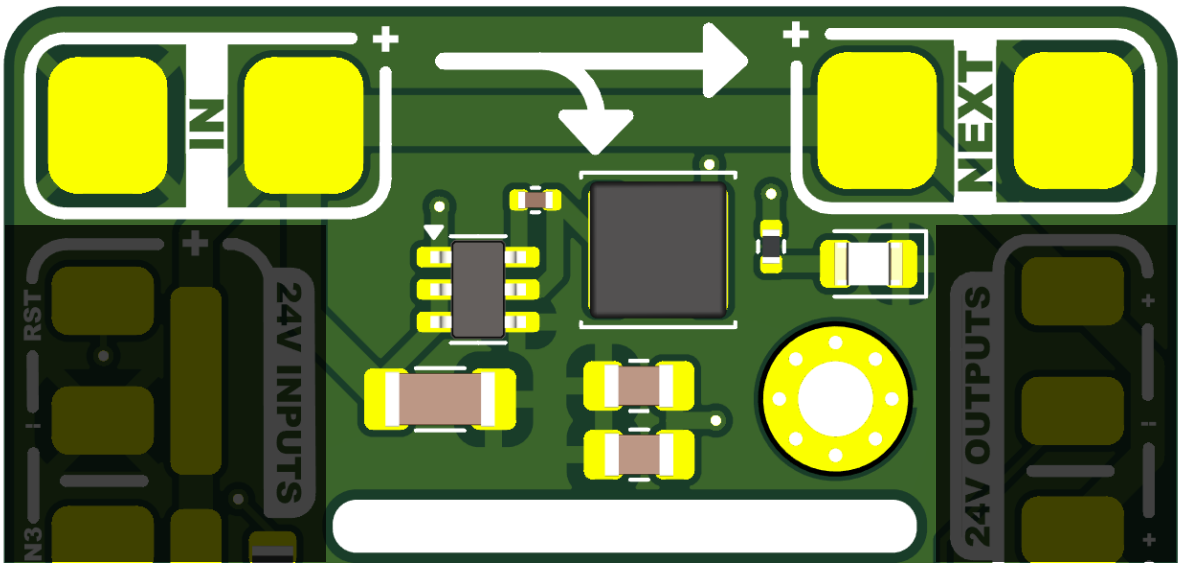
Key components:

- **C10 (10 µF)**: Input bulk capacitor to stabilize VIN and suppress input ripple.
- **C11 (100 nF)**: Bootstrap capacitor required for high-side gate drive.
- **L1 (3.9 µH)**: Power inductor selected for 2 A operation with low DCR.
- **C12, C13 (2 × 22 µF)**: Low-ESR MLCCs used for output filtering and voltage stability.
- **R21 + D3**: 3.3 V power indicator LED (≈10 mA current draw).



Power Distribution Chain:

The board includes passthrough pads for seamless power distribution of the 24 V supply. When 24 V is applied at the IN header, it is directly routed to the NEXT header, allowing the next node in the chain to be powered.

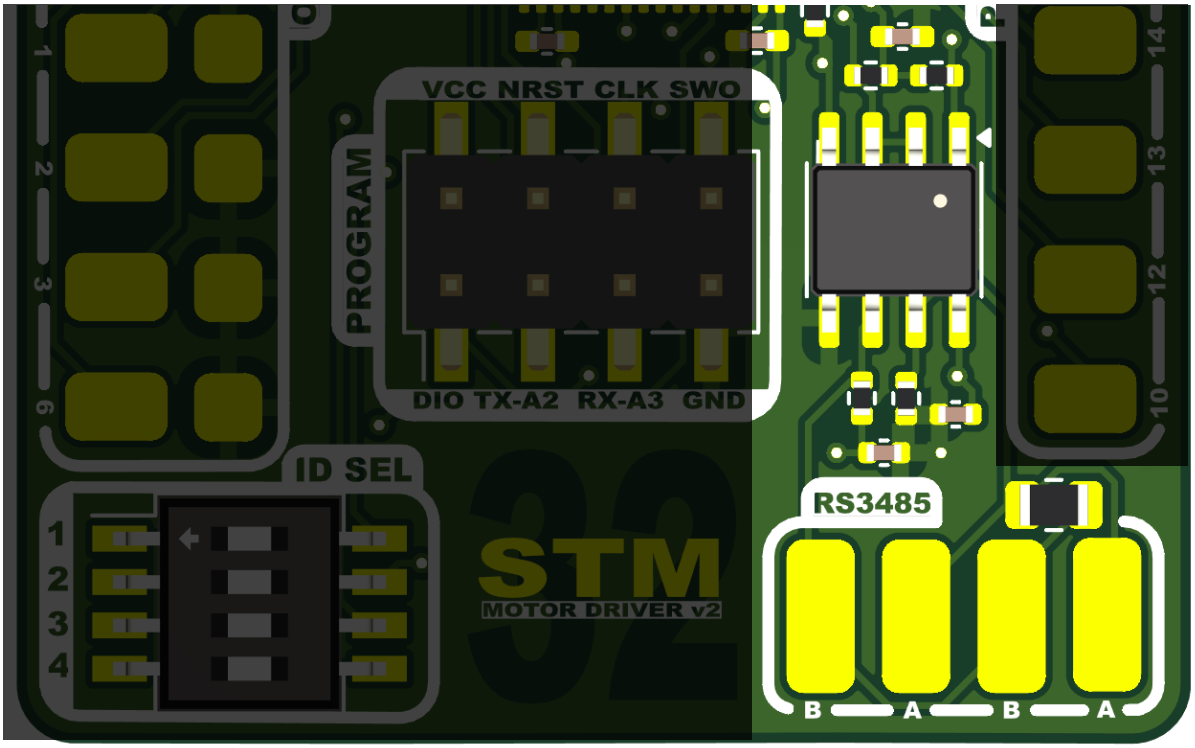


RS3485 Communication

The board uses a MAX3485 RS3485 transceiver to communicate over a half-duplex RS3485 bus. It is designed to support daisy-chaining of multiple motor nodes. The USART1 interface on the STM32 is used for communication as follows:

Function	STM32 Pin	Description
TX (DI)	PA9	Transmits RS3485 data
RX (RO)	PA10	Receives RS3485 data
(DE)	PA8	Data Enable

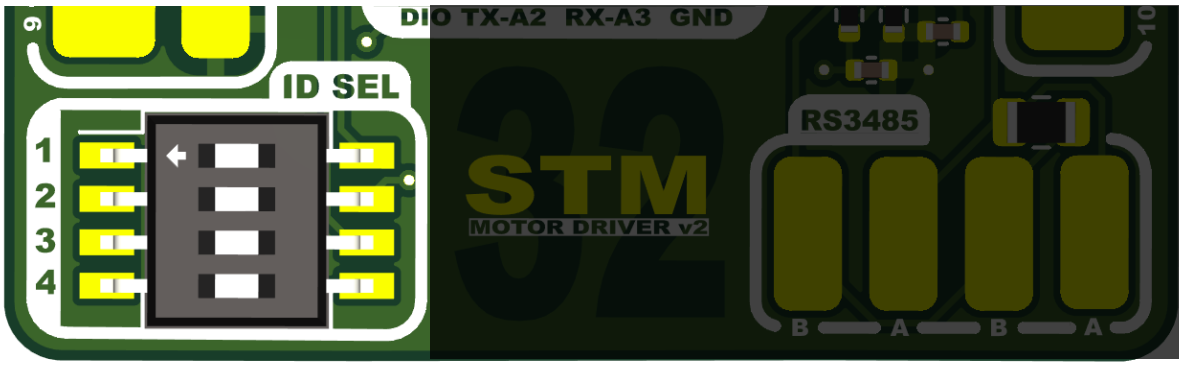
A footprint for an optional 120 Ω termination resistor is provided (0603)



ID Selection Header

Bit	STM32 Pin	DIP Switch	Description
0	PA7	SW1	Least Significant Bit
1	PB0	SW2	
2	PB1	SW3	
3	PB2	SW4	Most Significant Bit

Up to 16 nodes can be uniquely addressed using the 4-bit DIP switch.



Bill of Materials

Designator(s)	Footprint	Quantity	Value	LCSC Part #
C1, C7	0402	2	10pF	-
C10	1206	1	10uF	-
C11	0402	1	100nF	-
C12, C13	0805	2	22uF	-
C2, C3, C4, C5, C6	0402	5	100n	-
C8	0402	1	10uF	-
C9	0402	1	0.1uF	-
CBULK1	0603	1	10u	-
D1	0603	1	TEST	C12065
D3	0805	1	SUPP	C375454
J1, J7	4pin	2	Conn_01x04_Pin	-
J10, J11	24v	2	24V_RAIL	-
J2	10pinSMD	1	PORTB+24V_INPUTS	-
J3	PinHeader_2x04_P2.54mm_Vertical_SMD	1	Conn_02x04_Odd_Even	-
J4	10pinSMD	1	PORTC+24V_OUTPUTS	-
J5	2pinBIG	1	24V_IN	-
J6	2pinBIG	1	24V_OUT	-
J8	4d	1	MAX3485_PADS	-
J9	10pinSMD_1	1	GND_RAIL	-
L1	L_Changjiang_FNR4030S	1	3.9uH	C167872
R10, R11, R3, R4	0402	4	220R	-
R12, R16, R17, R19, R5, R6, R7	0402	7	10k	-
R13, R14, R15, R18	0805	4	4.7k	-
R2	0402	1	500R	C4125
R21	0402	1	330R	-
R8, R9	0402	2	4.7k	-
RTERM1	0805	1	120	-
SW2	SW_DIP_SPSTx04_Slide_Copal_CHS-04B_W7.62mm_P1.27mm	1	DIPSWITCHES	C3293144
U1	LQFP-64_10x10mm_P0.5mm	1	STM32F446RETx	C69336
U2	SO-8_3.9x4.9mm_P1.27mm	1	MAX485E	C558792
U3, U5	SOIC-16_4.55x10.3mm_P1.27mm	2	TLP291-4	-
U6	TSOT-23-6	1	AP63203WU	-
Y1	Crystal_SMD_3225-4Pin_3.2x2.5mm	1	16MHz	-