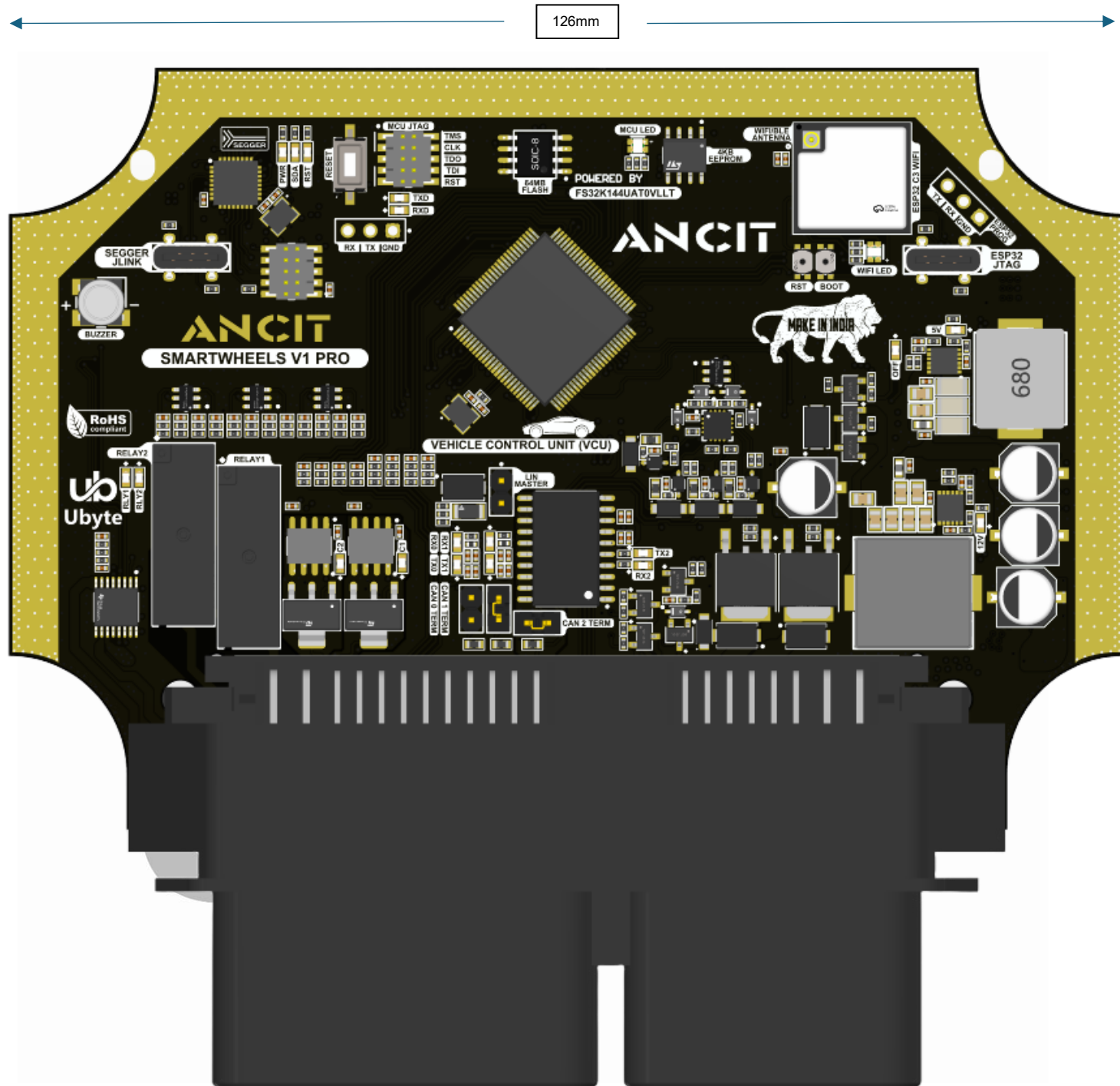
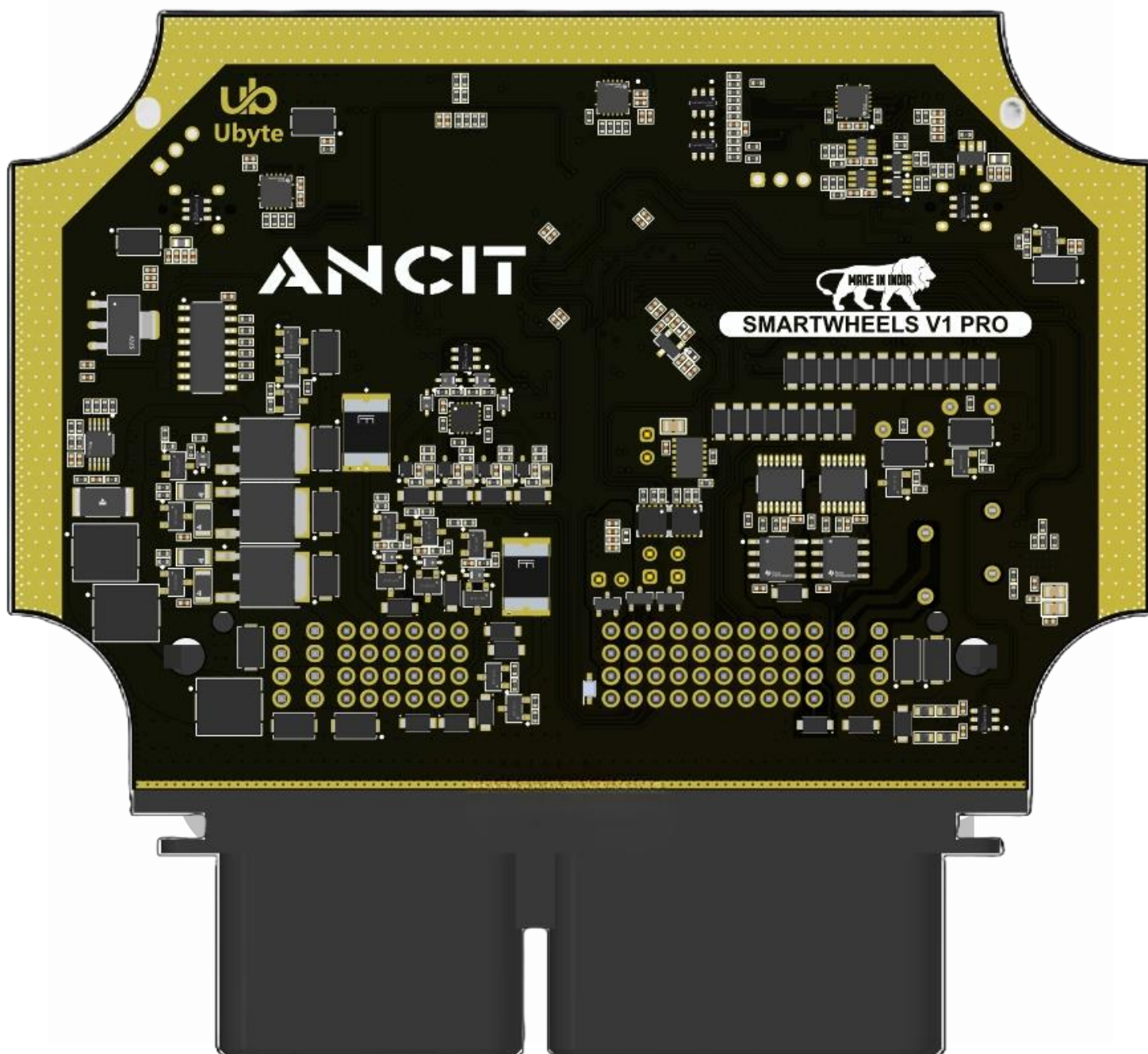
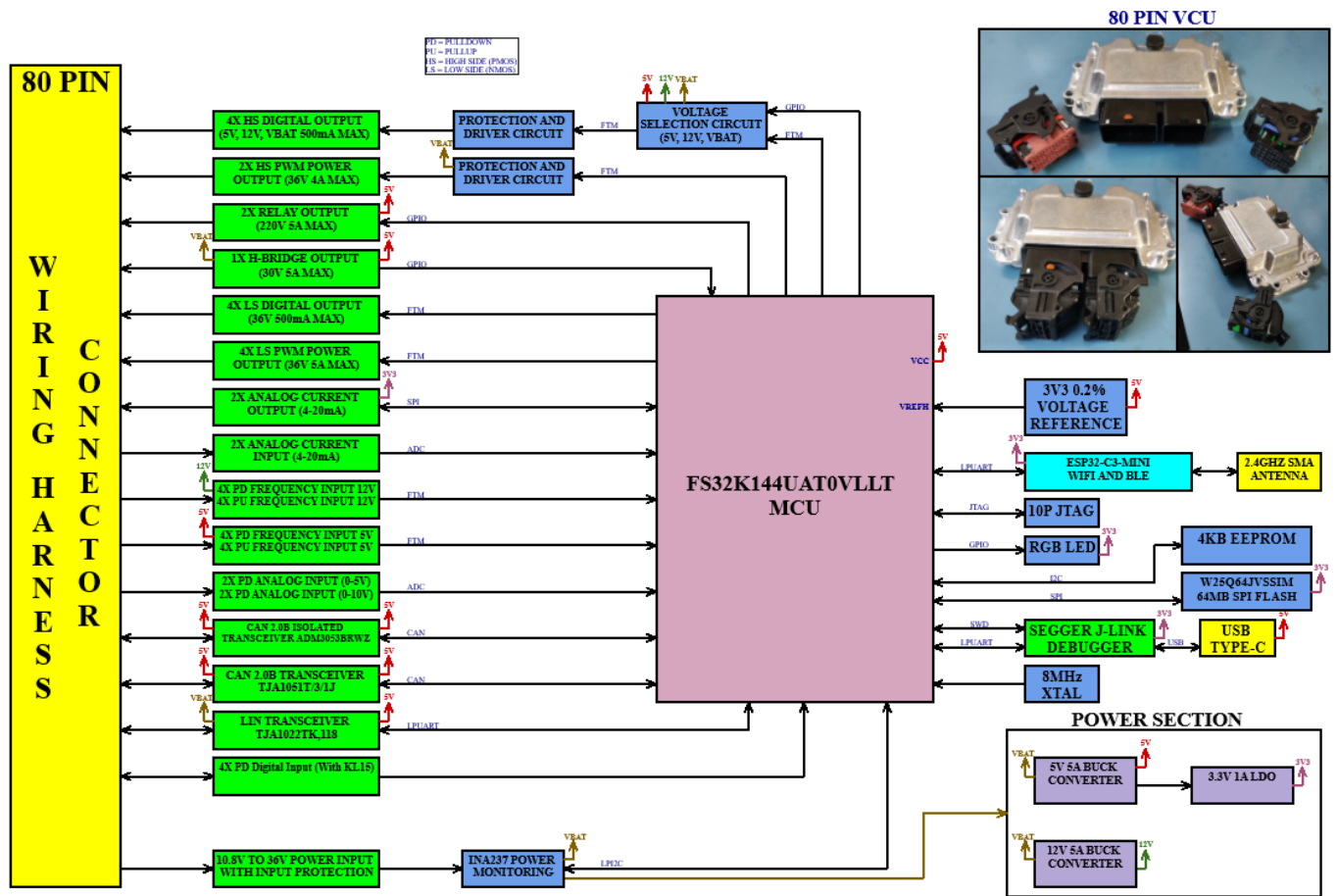


SMARTWHEELS V1 Pro HARDWARE DOCUMENTATION







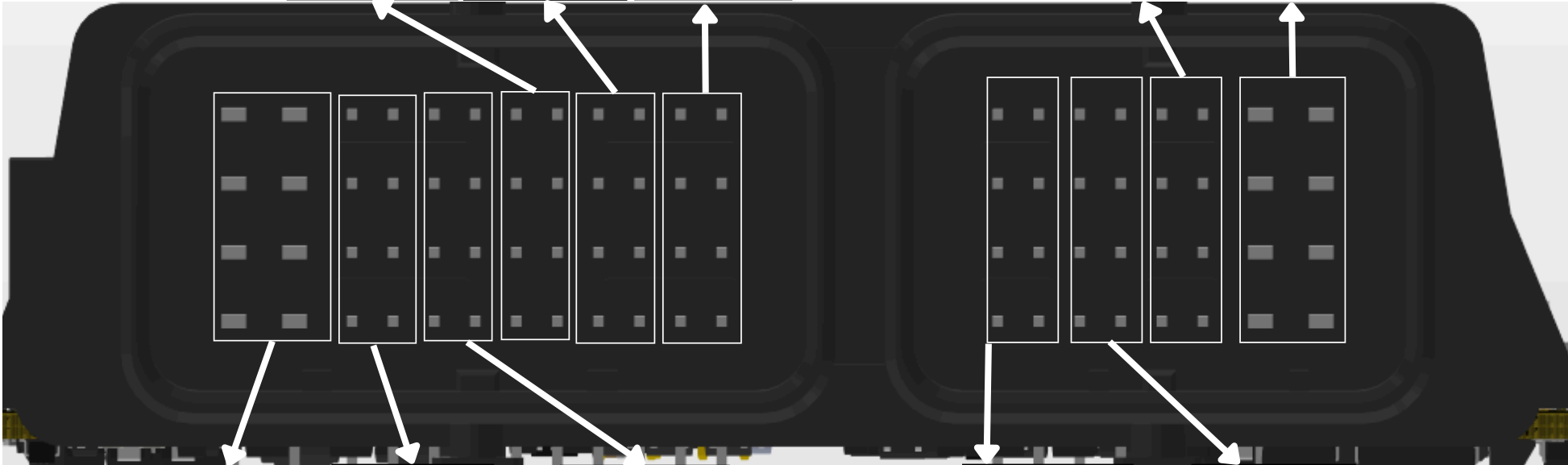
Smartwheels V1 Pro Hardware Block Diagram

Ubyte

| | | | |
|----------|----------------------|--------|------------------------------|
| HS_PWM | High side PWM | ISOCAN | Isolated CAN |
| LS_PWM | Low Side PWM | 5V_DIG | 5v Digital |
| ADJ-FRQ | Adjustable Frequency | HS_DIG | High Side PWM Digital Output |
| 0-10_ANG | 0V-10V Analog Inputs | | |

| | | | | | |
|--------------|-------------|-------------|-------------|-------------|-----------|
| 0-10_ANG_CH3 | KL15_IN | 12V_DIG_CH2 | CAN4_P | CAN3_P | ISOCAN1_N |
| 0-10_ANG_CH4 | 12V_DIG_CH3 | 12V_DIG_CH1 | CAN4_N | CAN3_N | ISOCAN_P |
| 12V_FRQ_CH4 | 5V_FRQ_CH7 | 5V_FRQ_CH6 | ADJ_FRQ_CH7 | ADJ_FRQ_CH5 | CAN1_GND |
| 12V_FRQ_CH3 | 5V_FRQ_CH8 | 5V_FRQ_CH6 | ADJ_FRQ_CH8 | ADJ_FRQ_CH6 | LIN1 |

| | | | |
|------------|------------|-----|-----|
| HS_PWM_CH2 | HS_PWM_CH1 | GND | GND |
| HS_PWM_CH2 | HS_PWM_CH1 | GND | GND |
| 12V | VIN | VIN | VIN |
| 12V | VIN | VIN | VIN |



| | | | | | |
|------------|------------|-------------|-------------|-------------|--------------|
| Relay2_COM | Relay1_COM | 4-20mA_CH1+ | 0-5_ANG_CH1 | 0-5_ANG_CH3 | 0-10_ANG_CH1 |
| Relay2_NO | Relay1_NO | 4-20mA_CH1- | 0-5_ANG_CH2 | 0-5_ANG_CH4 | 0-10_ANG_CH2 |
| OUT2_HB1 | 4-20mA_CH2 | 4-20mA_CH2+ | 5V_FRQ_CH2 | 5V_FRQ_CH4 | 12V_FRQ_CH1 |
| OUT1_HB1 | 4-20mA_CH1 | 4-20mA_CH2- | 5V_FRQ_CH3 | 5V_FRQ_CH1 | 12V_FRQ_CH2 |

| | | | |
|------------|------------|------------|------------|
| HS_DIG_CH2 | HS_DIG_CH1 | LS_PWM_CH2 | LS_PWM_CH1 |
| HS_DIG_CH3 | GND | LS_PWM_CH2 | LS_PWM_CH1 |
| HS_DIG_CH4 | GND | GND | GND |
| LS_DIG_CH4 | LS_DIG_CH3 | LS_DIG_CH2 | LS_DIG_CH1 |

POWER SECTION:

The board can be powered from 80 pin automotive connector, SEGGER JLINK USB Type C and ESP32 JTAG USB Type C.

- **80-pin automotive connector:** This is the primary power source for the Smartwheels V1 Pro, which powers all the components.
- **SAGGER J-Link:** This method powers on the components that require a 5V input, such as the microcontroller (like the ESP32), relays, etc. This setup uses USB Type C power input via the J-Link, allowing for debugging and programming, while also powering up the Smartwheels V1 Pro main components.

Peripherals which will not work are: -

1. Dual LIN.
2. High Side PWM Output.
3. Buck convertors.

ESP32 JTAG: Using JTAG to power on the ESP32 powers only the ESP32 microcontroller and its associated components (like the onboard LED), but not the entire board. This is typical for debugging or programming the ESP32 in isolation, without powering the entire Smartwheels V1 Pro.

NOTE- while powering board with USB Type C, UVLO LEDS of both convertors will light up indicating that both convertors are not working.

The Power Input contains 2 bidirectional diodes for ESD and Surge Protection (TVS/ESD). The Power Section contains 2 High Voltage Buck converters for obtaining 5V, 12V from 6V to 36V and 13V to 36V respectively and a LDO for obtaining 3.3V from 5V. All the 2 converters and LDO are enabled all the time and don't require inputs from the microcontroller for functioning. It should be noted that the converter will turn off in case UVLO is triggered as per the given specification. Each of the 2 Power Converters have LED indicators. The 5V and 12V LEDs will be triggered if there is fault in Buck converter. LEDs are labeled as the voltage of the power converter that they are connected to. Output of 12V buck converter have TVS diodes to protect against any unwanted spike that may occur at the output of the buck converter.

5V Converter Key specifications:

- Input Voltage: 6V to 36V
- Output Voltage: 5V
- Output Current: 5A continuous
- UVLO set voltage: 6V
- Switching Frequency: 504KHz
- Efficiency: 89.8%

12V Converter Key specifications:

- Input Voltage: 13V to 36V
- Output Voltage: 12V
- Output Current: 5A continuous
- UVLO set voltage: 13V
- Switching Frequency: 357KHz
- Efficiency: 90.2%

3.3V LDO Key specifications:

- IC name: AMS1117
- Input Voltage: 5V (taken from 5V buck converter)
- Output Voltage: 3.3V
- Output Current Max: 1A
- Line Regulation: 0.2%
- Load Regulation: 0.4%

The power section also includes the following protection / features on the power input

1. Reverse Polarity protection
2. Transient Voltage Protection (Breakdown Voltage 40V)

Input Power Monitoring

Input Voltage and Current to the Smartwheels V1 Pro are monitored by the INA237 power monitoring IC. The readings are taken by the microcontroller and can be sent to the cloud by the user. These readings can also be used to issue warnings to the user for unexpected behaviors of input power supply to the Smartwheels V1 Pro and unusual current consumption patterns that might be experienced indicating a problem with the Smartwheels V1 Pro or the device connected to the power output of the Smartwheels V1 Pro.

Input Monitoring Specifications

- Max Current (ADCrane=1): 5.8514A
- Max Current (ADCrane=0): 30A
- Max Voltage: 85V
- Resolution: 16bit
- I2C address: 0x41

H-Bridge

The Smartwheels V1 Pro has been fitted with a H-Bridge Motor Driver with Integrated Current Sense and Regulation. A low-power sleep mode achieves ultra-low quiescent current draw and Internal

protection features include supply undervoltage lockout, charge pump undervoltage, output overcurrent, and device overtemperature. Fault conditions are indicated on nFAULT.

Specifications

- VREF: 2.5V
- Trip Current: 5A
- RIPROPI = $(2.5/2.25) K = 1.11K$

Other Specification can be referred to from the datasheet of the IC: [DRV8874 H-Bridge Motor Driver With Integrated Current Sense and Regulation datasheet \(Rev. A\)](#)

Isolated CAN Transceivers

The Smartwheels V1 Pro has been fitted with an isolated CAN transceiver that allows for large common mode voltage tolerance at the CAN transceiver. The Isolated CAN circuit is based on the ISO 11898 isolated CAN transceiver IC and isoPower integrated isolated dc-to-dc converter.

Specifications

- 2.5 kV rms signal and power isolated CAN transceiver
- 5 V or 3.3 V operation on V_{IO}
- Complies with ISO 11898 standard
- High speed data rates of up to 1 Mbps
- High common-mode transient immunity: $>25 \text{ kV}/\mu\text{s}$

Other Specification can be referred to from the datasheet of the IC: [ADM3053 \(Rev. E\)](#)

Non-Isolated CAN Transceivers

The Smartwheels V1 Pro has been fitted with 2 Non-isolated CAN transceiver that is designed for CAN FD, CAN FD with Extended frame and Standard CAN operation.

Specifications

- ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5 compliant
- AEC-Q100 qualified
- Termination Type: 120-ohm termination (Can be enabled and disabled through jumper)
- Maximum Signaling Rate: 5 Mbps

Other Specification can be referred to from the datasheet of the IC: [High-speed CAN transceiver](#)

Dual LIN Transceiver

The Smartwheels V1 Pro has been fitted with a Dual LIN Transceiver that provides the interface between a Local Interconnect Network (LIN) master/slave protocol controller and the physical bus in a LIN network.

LIN_TXD is connected with PTA9_LPUART2_TX

LIN_RX is connected with PTA8_LPUART2_RX

Specifications

- LIN 2.0, LIN 2.1, LIN 2.2, LIN 2.2A, ISO 17987-4:2016 (12 V LIN) and SAE J2602 compliant.
- Baud rate up to 20 kBd.
- Input levels compatible with 3.3 V and 5 V devices.

- K-line compatible.

Other Specification can be referred to from the datasheet of the IC: [TJA1022.fm](#)

Analog Inputs

The analog inputs of the Smartwheels V1 Pro have the following specifications

- Input Voltage Range: 0V to 10V
- Maximum Input Voltage: 11V
- Transient voltage Protection: Yes
- Total Pulldown Resistance: 25K ohms
- ADC Resolution: 12 Bit

High Speed Inputs (Pulled-up)

- Input Voltage Range: 0V to 31V
- Maximum Input Voltage: 31V
- Transient voltage Protection: Yes
- Total Pulldown Resistance: 20K ohms
- Pullup Voltage: 5V, 12V or VBAT
- Cutoff Frequency: 1.5KHz
- Trigger Point at 5V: 2.4V to 4V
- Trigger Point at 12V: 2.4V to 4V
- Trigger Point at 30V: 2.4V to 4V

High Speed Inputs 12V (Pulled-down)

- Input Voltage Range: 0V to 15V
- Maximum Input Voltage: 15V
- Transient voltage Protection: Yes
- Total Pulldown Resistance: 30K ohms
- Cutoff Frequency: 7.95KHz

High Speed Inputs 5V (Pulled-down)

- Input Voltage Range: 0V to 5.25V
- Maximum Input Voltage: 6V
- Transient voltage Protection: Yes
- Total Pulldown Resistance: 21K ohms
- Cutoff Frequency: 15.9KHz

Relay Output

The relay has the following specifications. For more details, refer to the datasheet [HF46F en.FH11](#)

- Maximum Switching Voltage: 277VAC / 30VDC
- Maximum Switching Current: 5A
- Isolation: 10KV Peak

Storage

The Smartwheels V1 Pro has been fitted with W25Q64 64MB Flash and M24C04 4KB EEPROM (Electrically Erasable Programmable Read-Only Memory)

W25Q64 64MB Flash works on 4 Wire SPI Interface and M24C04 4KB EEPROM comes with standard I2C Interface.

Specifications of W25Q64 64MB Flash

- Memory Size: 64Mbit
- Interface: SPI
- Clock Frequency: 133MHz

Other Specification can be referred to from the datasheet of the IC: [W25Q64JV Datasheet](#)

Specifications of M24C04 4KB EEPROM

- Memory Size: 4Kbit
- Write Cycle Endurance: 1,200,000 times
- Interface: I2C

Other Specification can be referred to from the datasheet of the IC: [m24c04-r.pdf](#)

Buzzer

The Smartwheels V1 Pro integrated a passive buzzer that can be used as an alarm by the users or generate audible feedback, etc. The Buzzer must be driven by a 4KHz 50% duty cycle square wave from the microcontroller.

Specifications

- Frequency: 4KHz
- Loudness (at 10cm): 75db

Wireless Communication

- WiFi
- Bluetooth

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