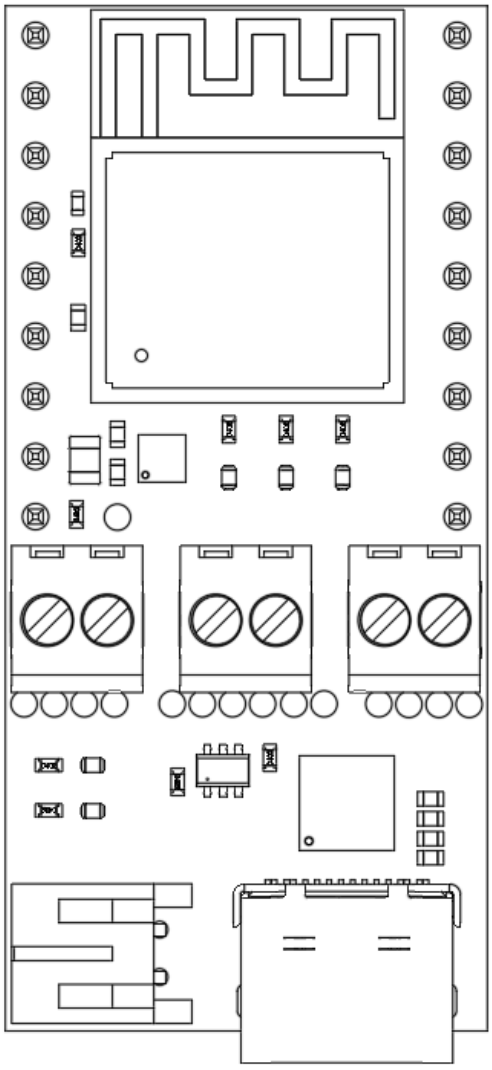
TITAN CORE

HAPTIC DEVELOPMENT BOARD

Wideband, High-Definition (HD)
prototyping platform for electronic devices

Product: TITAN CORE Dev board V2.1
Product ID: TC-153286-B

Revised: 02/12/2026



FEATURES:

- **Drives up to three TITAN wideband motors**
- **On-board ESP32 PICO mini**
- **I²C, SPI, UART, GPIO expansion headers**
- **USB-C power & data + Li-Po charger**
- **Low-power standby <25 µA; deep-sleep wake on BLE or GPIO**
- **Compatible with Vector Haptics APIs and TITAN software suite**

1. Introduction

1.1 Overview

The **TITAN Core Haptics Development Board** is a compact, production-ready hardware platform designed for rapid prototyping and seamless integration of haptic feedback into consumer electronics. It integrates a powerful ESP32 chip, advanced motor driver channels, and wireless connectivity in a small footprint.

Primary Uses:

- Prototyping with TITAN and other haptic motors (TacHammer LMR, ERM, LRA, etc.)
- Development of devices for wearables, gaming, XR/VR controllers, and other consumer devices
- Production board for devices involving haptic motors

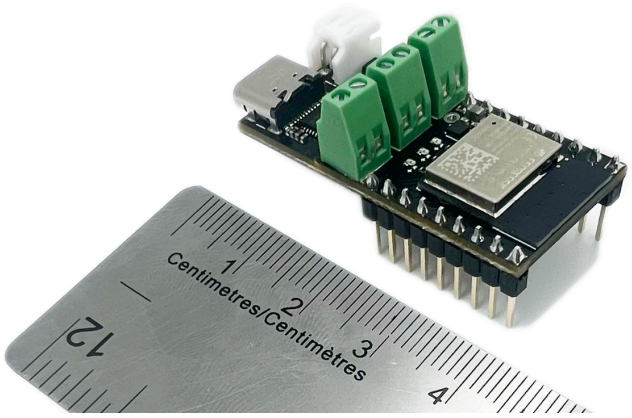


Figure 1.1. TITAN Core Haptics Development Board

1.2 Key Features

Feature	Details
Processor	ESP32 (32-bit, dual-core) with ultra-low power consumption, integrated Wi-Fi, and Bluetooth.
Connectivity	Wi-Fi 802.11 b/g/n, Bluetooth v4.2 BR/EDR and BLE, USB-C interface.
Amplified motor channels	Supports up to three motors simultaneously via screw-in headers.
Supported Motors	Optimized for TITAN's Linear Magnetic Ram (LMR) motors, including Carlton and Drake. May also be used with Eccentric Rotating Mass (ERM) and Linear Resonant Actuator (LRA) motors.
Firmware	Preloaded Vector Haptics Firmware with sample effects for rapid testing and development of haptic effects.
Power Input	Supports USB-C, 3.3V-6V bench power supply, and LiPo battery (1S, JST-PH2 male connector). Supports up to 11V output (contact TITAN for applications above 5V).
Supported Firmware IDEs	Compatible with Arduino IDE and Platform IO for flexible and scalable development.
Power Management	Supports 1c battery charging via USB or external power sources.
Modular Board	USB and Power management PCB can be detached for a smaller footprint.
Certifications	ISO9001, ISO13485, ISO14001 and UL certified

1.3 Applications

Ideal for prototyping and developing new devices in:

1. **Wearable Technology**: Smartwatches, fitness bands, and medical devices that benefit from compact, precise tactile cues
2. **Gaming & XR/VR**: Handheld controllers, gloves, and other peripherals where low-latency, wideband feedback deepens immersion
3. **Mobile & Consumer**: Rapid prototyping of phone accessories, smart cases, and IoT endpoints
4. **Research & Development**: Academic, corporate, and start-up labs exploring advanced haptic patterns and control algorithms

2. Technical Specifications

2.1 Electrical Specifications

Parameter	Min	Typ	Max	Units	Notes
Supply Voltage (Vin)	3.3	5	6	V	Via USB-C or external pin
Regulated 3.3V Output	-	3.3	-	V	Sourced from onboard regulator
Peak Current (Motors)	–	-	-	A	Dependent on motor driver usage
Battery Input (1S LiPo)	3.0	3.7	4.2	V	JST connector; includes charge circuitry
Battery Charging Rate	-	500	-	mA	Auto-limited by onboard charger
Logic-Level IO Voltage	2.0	3.3	3.6	V	Refer to Section 3 for IO pin tolerances

1. **Supply Voltage**: The board can be powered via USB-C (5V) or from an external supply (3.3–6.0 V), with an onboard regulator supplying 3.3V to the system.
    a. M-Channel (DRV 8212) can be provided with up to 11.0V via dedicated through hole terminals
2. **Battery Compatibility**: A 1S LiPo battery can be directly connected; the onboard charging circuit supports 500mA charge current.
3. **Power Consumption**: Power draw varies based on Wi-Fi/Bluetooth activity, motor load, and any attached peripherals.

2.2 Mechanical Specifications

Parameter	Typical Value	Units	Notes
Board Dimensions (L × W × H)- FULL	44.6 x 20.3 x 18.4 (with pin headers)	mm	Main PCB outline, excluding any protrusions
Board Dimensions (L × W × H)- without USB & Power Management	29.1 x 20.3 x 18.4 (with pin headers)	mm	Main PCB outline, excluding any protrusions
Weight - FULL	8.25	g	Includes onboard connectors, excludes motors
Weight - without USB & Power Management	6.15	g	Includes onboard connectors, excludes motors
Connector Types	USB-C, JST-PH2	–	Reference Section 3 for pin mapping

Figure 2.1 Board Outline (Full)

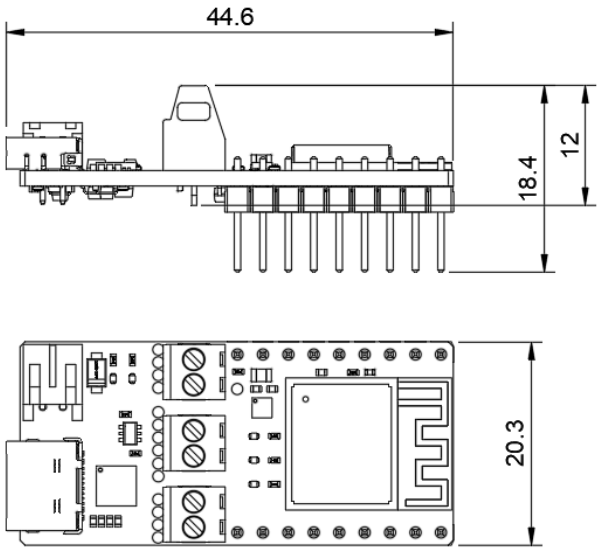
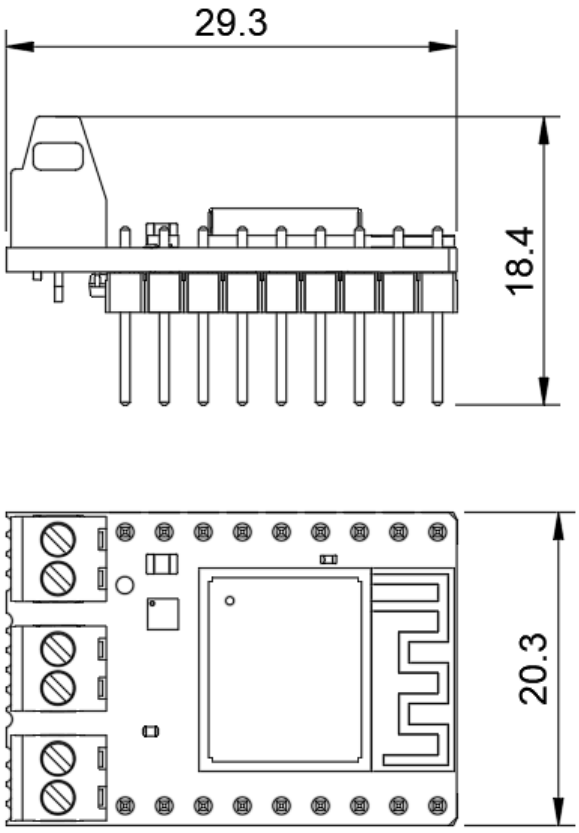


Figure 2.2 Board Outline (Snapped)



2.3 Performance Specifications

1. **Processor / SoC (ESP32-PICO-MINI-02-N8R2)**

Category	Subcategory	Specification
Core Speed	-	Up to 240 MHz
Internal Memory	Boot & core functions (ROM)	448 KB
-	Data & instructions (SRAM)	520 KB
-	RTC (SRAM)	16 KB
-	SPI Flash	8 MB
-	PSRAM	2 MB
Wireless (802.11 b/g/n)	Bit rate: 802.11n	150 Mbps
Bluetooth	Bluetooth Classic and Bluetooth LE	V4.2

2. **Haptic Motor Driver – DRV8212PDSGR**

Parameter	Value
Driver Type	H-Bridge
Maximum Voltage	12V
Max Continuous Current/Channel	4A
Supported Drive Types	ERM, LRA, TacHammer, etc.

3. **Audio Amplifier Driver – PAM8403DR-H**

Parameter	Value
Driver Type	Class-D Audio Amplifier
Maximum Voltage	5V
Max Continuous Current/Channel	0.6A

2.4 Environmental & Reliability

Parameter	Min	Max	Units	Notes
Operating Temperature Range	-40	85	°C	Ambient temperature around the PCB
Operating Humidity	10%	90%	RH	Non-condensing conditions
Shock & Vibration	–	–	–	Compliant with [IEC 60068-2-x tests]

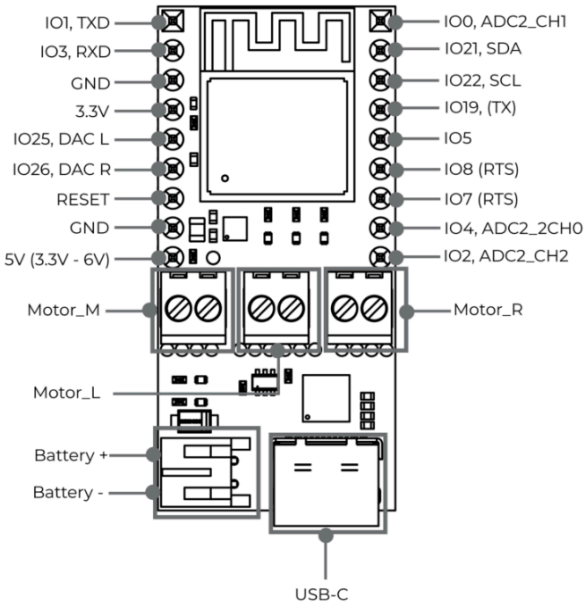
2.5 Additional Notes & References

- **Vendor Documents**: For detailed SoC specs, see ESP32 Vendor Datasheet, DRV8212 Haptic Driver Datasheet, PAM8403
- **Certifications**: ISO9001, ISO13485, ISO14001 and UL certified
- **System Integration**: Confirm that system-level load does not exceed power supply or regulator specifications.

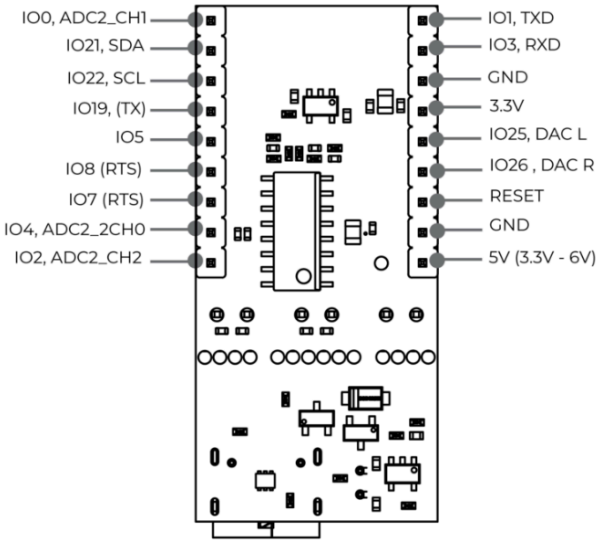
3. Pinout and Connectivity

3.1 Pin Diagram

Top



Bottom



3.2 Pin Descriptions

Pin	Function	Description
IO0	Boot/RTC/ADC2_CH1	Boot mode, real-time clock
IO1	TXD	UART Transmit
IO2	ADC2_CH2	Analog input, RTC function
IO3	RXD	UART Receive
IO4	ADC2_CH0	Analog input, RTC function
IO5	GPIO	General-purpose I/O
IO7	CTS/U2CTS	UART Clear to Send
IO8	RTS/U2RTS	UART Request to Send
IO13	LED_R	Red LED output
IO14	LED_G	Green LED output
IO15	Shutdown	Motor driver shutdown control
IO19	TX	UART transmit
IO20	LED_B	Blue LED output
IO21	SDA	I2C data line
IO22	SCL	I2C clock line
IO25	DAC L	Left DAC output
IO26	DAC R	Right DAC output
IO27	PWM_2	Motor driver PWM input
IO32	SLEEP	Motor driver sleep control
IO33	PWM_1	Motor driver PWM input

GND	Ground	Common ground
3.3V OUT	Power Output	Regulated 3.3V output for peripherals
5V	Power Input	Primary 5V input via USB-C or power supply
RESET	Reset	System reset
VIN	Power Input	External power supply input

GPIO Pins are configurable as digital inputs/outputs, PWM signals, serial interfaces, and more. See Section 3.4 for details on communication protocols.

Connectors

Connector Type	Description
JST PH 2.0	Battery connection (compact, polarized)
USB-C	Power input and data communication
Green Screw Terminals	Motor connections (secure, removable wiring)

Special Function Pins:

- **BOOT / EN**: Used to place the board into firmware flashing or low-power modes.
- **Reset**: Resets the microcontroller when pulled low.

3.3 Motor Driver Outputs

The TITAN Core board includes integrated haptic driver channels for connecting various motor types. Each channel is typically an H-Bridge output with PWM capability.

Channels

Device	Channels
PAM8403 Dual Audio Amplifier	L+, L-, R+, R-
DRV8212 H-Bridge Motor Driver	M+, M-

Maximum Power per Channel

Device	Voltage
PAM8403 Dual Audio Amplifier	5V
DRV8212 H-Bridge Motor Driver	12V

Default Channel Mapping

Channel	GPIO Pin
Channel L	IO25
Channel R	IO26
Channel M - PWM_1	IO33
Channel M - PWM_2	IO27
Motor Shutdown (Audio)	IO15
Motor Shutdown (Motor)	IO32

3.4 Communication Interfaces

The onboard microcontroller (e.g., ESP32) supports multiple serial protocols on configurable pins. Each interface shares certain GPIOs by default, but many can be remapped via firmware.

Interface	Default Pins	Typical Uses	Notes
UART	TX: IO1 RX: IO3	Serial console for debugging and firmware updates	-
I2C	SDA: IO21 SCL: IO22	Interfacing with sensors, additional driver ICs, or displays	-
SPI	SCLK: IO18 MOSI: IO23 MISO: IO19 CS: IO5	High-speed communication with external peripherals (displays, DACs, etc.)	Must be enabled/configured in firmware
I2S	Any IO pin (except IO0)	Audio data streaming, advanced haptic waveforms (if supported)	-
PWM	PWM_1: IO33 PWM_2: IO27	-	-
Sleep Control	IO32	-	-

3.5 LED Indicators

There may be several onboard LEDs for status indication:

LED Type	GPIO Pin	Description
Power LED	IO14	Illuminates when the board is powered
RGB - Red	IO13	Addressable Red LED
RGB - Green	IO14	Addressable Green LED
RGB - Blue	IO20	Addressable Blue LED
Charge LED - Green	—	On when USB power is connected
Charge LED - Red	—	On while charging, turns off when battery is full

4. Electrical Characteristics & Recommended Operating Conditions

This section provides detailed electrical ratings that must be observed for reliable board operation. Always review the Absolute Maximum Ratings before applying power or signals to the TITAN Core board to avoid permanent damage.

4.1 Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit	Notes
Supply Voltage (Vin)	V_IN_MAX	6.0	V	Voltage on 5V or VIN pins above which damage may occur
GPIO Voltage	V_GPIO_MAX	3.6	V	Do not exceed SoC I/O voltage levels
Motor Driver Current (Peak)	I_DRV_PEAK	2.0	A	Short bursts allowed; sustained operation must be lower
Operating Temperature	T_OPR_MAX	60	°C	Above this temperature, performance is not guaranteed
Storage Temperature	T_STG_RANGE	-20 °C to 70 °C	°C	Safe range for shipping/storing the board

Caution: Exceeding these ratings may cause permanent damage. Functional operation outside the recommended conditions is not guaranteed.

4.2 Recommended Operating Conditions

Parameter	Min	Typ	Max	Units	Notes
Supply Voltage (Vin)	4.75	5.0	5.25	V	Via USB-C or external supply; regulated on board
3.3V Output Current	–	-	500	mA	Sum of external devices powered by 3.3V pin
Motor Driver Current	–		1.2	A	Per channel; depends on motor characteristics
Ambient Temperature	0	25	50	°C	With free airflow; see Section 2.4 for environment
Relative Humidity	10	–	85	%	Non-condensing environment

Notes:

1. For extended temperature ranges, consult with an SoC vendor datasheet or motor driver manufacturer.
2. For continuous high-current motor driving, ensure proper heat dissipation.

4.3 Typical Power Consumption

Mode	Wi-Fi Active	Motor Load	Typical Current	Notes
Idle (No Wireless)	Off	None	20 mA	MCU in Light Sleep
Light Operation	On (Idle)	None	80 mA	Wi-Fi stack active, no heavy tasks
Heavy Motor Use	On (TX/RX)	100 % load	300 mA / 1.2 A	Varies with motor duty cycle

5. Compliance & Certifications

5.1 Regulatory Approvals

FCC (U.S.)

- **FCC ID**: 2AAXT-ESP32PM02
- **Device class**: Part 15 Subpart C

5.2 Safety & Environmental

- **UL**: ISO9001, ISO13485, ISO14001 and UL certified
- **Battery Safety**: Onboard LiPo charging circuit tested to IEC 62133

Note: System-level certification is required when embedding this board in commercial products. Refer to local regulatory bodies for final product compliance.

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