CAN-FD-SIC Industrial HAT

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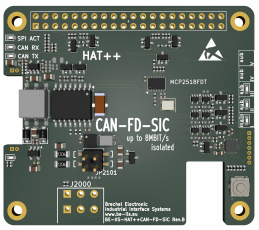

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Product Status: Development

CAN-FD with SIC supports data rates up to 8 Mbit/s over a differential two-wire bus, allowing reliable communication between multiple nodes within typical automotive and industrial network topologies.

This HAT enables multidrop communication based on CAN-FD with Signal Improvement Capability (SIC).

Key Features

- CAN-FD with SIC, up to 8 Mbit/s
- MCP2518FD CAN-FD controller
- TCAN1472 CAN-FD SIC transceiver
- Galvanically isolated transceiver
- Configurable 120 Ω termination
- RSP HAT+ compliant (2024)
- Stackable HAT (BE-IIS-HAT++)
- Configurable CS and IRQ routing
- Two connector options
- RoHS compliant
- Quality component suppliers

Product Description

The CAN-FD Industrial HAT is a Raspberry Pi HAT+ compliant interface board supporting CAN-FD with SIC according to ISO 11898.
It integrates an MCP2518FD controller and a TCAN1472 SIC transceiver with galvanic isolation between logic and bus interface.

Applications

- CAN and CAN-FD network evaluation
- Technology evaluation
- Prototyping
- Education and laboratory use

Contents

1 Introduction

The BE-IIS HAT++ CAN-FD-SIC Industrial HAT is a Raspberry Pi HAT+ compliant interface board for CAN and CAN-FD communication in industrial and laboratory environments.

The board integrates an MCP2518FD [1] CAN-FD controller and a TCAN1472 [2] SIC transceiver. Galvanic isolation separates the logic domain from the CAN bus domain.

The HAT supports multidrop CAN bus operation and can be used for evaluation, prototyping, test setups, and educational purposes.

2 Hardware Configuration

2.1 Main Features

The BE-IIS-CAN-FD-SIC HAT enables CAN-FD communication with Signal Improvement Capability (SIC) on Raspberry Pi platforms. It allows any standard Raspberry Pi (e.g. Raspberry Pi Zero or Raspberry Pi 3/4/5, excluding Compute Module variants) to act as a CAN-FD-SIC node. Communication between the Raspberry Pi and the CAN controller is implemented via the SPI interface with an interrupt line for efficient event handling.

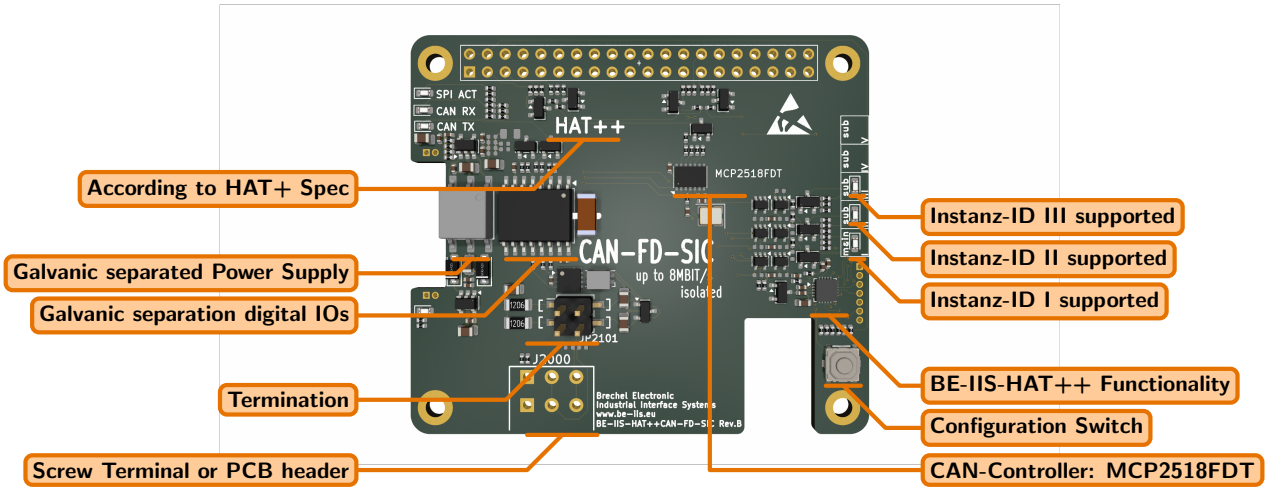


Figure 1: BE-IIS CAN-FD-SIC top view with annotations

CAN Controller

- Supplier: Microchip
- MCP2518FD CAN-FD controller
- MCP2518FD Crystal-Configuration: 40MHz

CAN Tranceiver

- Supplier: Texas Instruments
- TCAN1472 CAN-FD SIC transceiver

SPI Interface

- SPI0.0, SPI0.1, and SPI0.2 supported
- Persistent selection via push button

Isolation

- Galvanically separated interface
- Isolator rated up to 3 kV

Protocol Support

- Compatible with Classical CAN
- Compatible with CAN-FD
- CAN-FD with SIC support

Bus Topology

- Multi-node CAN bus architecture
- Node count depending on system design

Node Configuration

- Configuration via `ip` and SocketCAN
- Standard CAN arbitration supported

2.2 Block Diagram

The block diagram shown in Figure 2 is simplified. It illustrates the main functional blocks, power domains, isolation barriers, and the principal data paths of the system.

The interrupt signal routing is not shown. It is configured using the same scheme as the chip-select (CS) routing. Reset, and pull-up control signals is omitted for clarity as well.

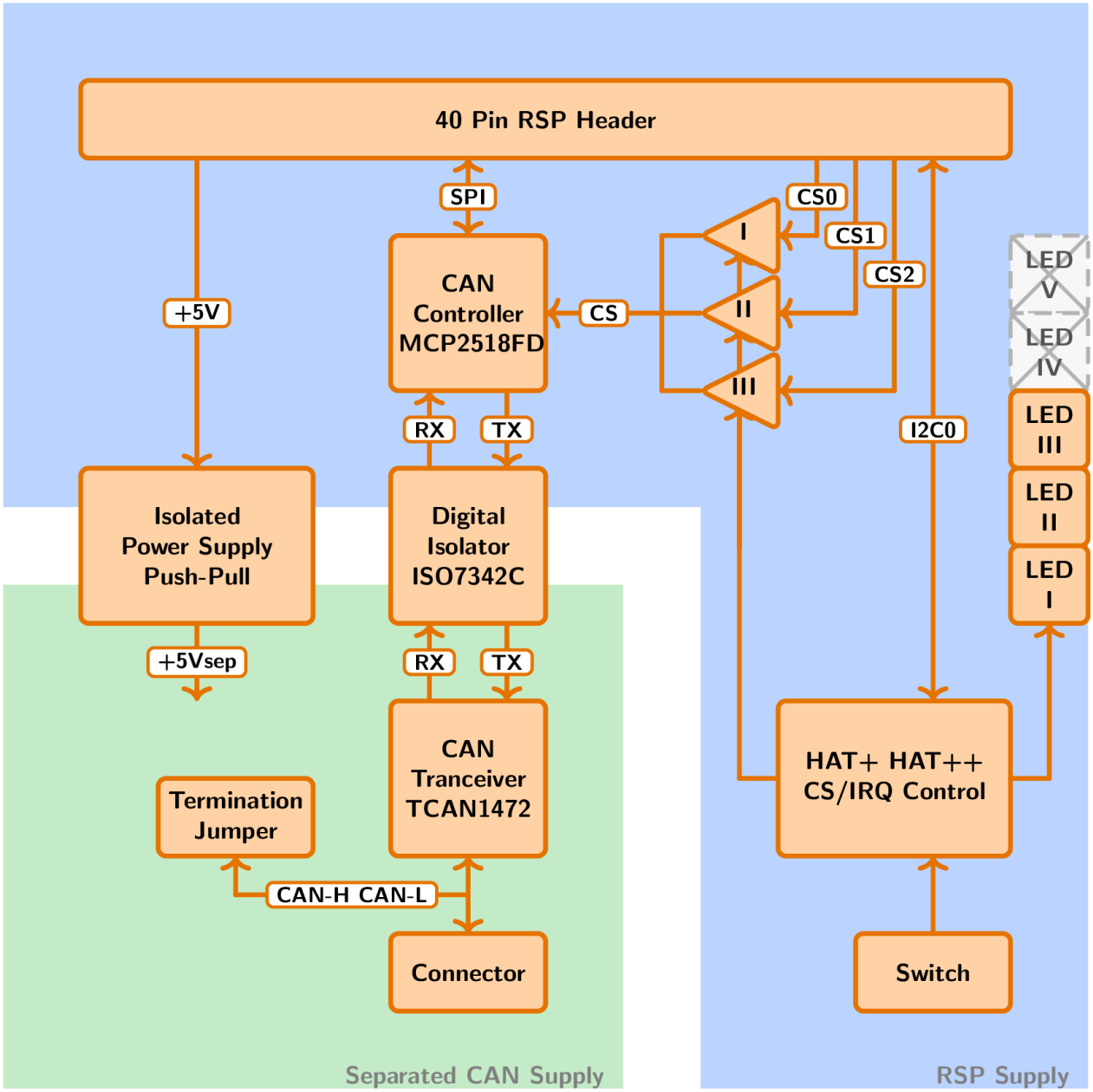


Figure 2: Simplified block diagram

2.3 Interfaces

The board interfaces with the host system via an SPI bus and a dedicated interrupt (IRQ) signal.

The SPI bus is used for communication between the Raspberry Pi (SPI master) and the onboard CAN controller (SPI slave). An interrupt line is used for event-driven communication.

The supported instance modes define the assignment of chip-select (CS) and interrupt (IRQ) signals:

Instance Mode	CS	IRQ
I	GPIO8	GPIO6
II	GPIO7	GPIO5
III	GPIO16	GPIO12

Table 1: Exclusive HW resources

Instance Mode	Signal	Pin
I & II & III	SCLK	GP11
I & II & III	MISO	GP9
I & II & III	MOSI	GP10
I & II & III	RESET	GP13
I & II & III	SCL0	GP1
I & II & III	SDA0	GP0

Table 2: Shared HW resources

The CS and IRQ signals are exclusively occupied by the HAT in each instance mode.

The SPI bus signals are shared across all instance modes. These signals may also be shared with additional HATs, provided that proper chip-select separation is ensured.

HAT+ / HAT++ functionality

The I^2C bus **I2C0** (SDA0 / SCL0) is reserved for HAT identification and configuration purposes.

An onboard MCU connected to I2C0 provides standard HAT+ identification data as well as extended HAT++ metadata. This includes, for example, device tree overlay references and configuration parameters used for automatic system integration.

The EEPROM content can be evaluated by the bootloader or by user-space software (e.g., via a systemd service) to dynamically apply device tree overlays and configure the system.

All other GPIO signals remain available for user applications, unless otherwise specified.

2.4 Isolation

Galvanic isolation is implemented between the CAN signaling domain and the Raspberry Pi domain.

The isolation barrier separates the bus-side circuitry from the logic-side circuitry, ensuring robust operation and protection against ground potential differences.

The isolation barrier is implemented using the following components:

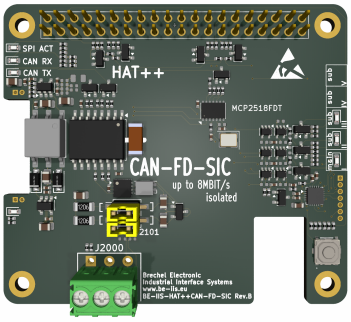
- Digital isolator: ISO7342C (400V working, 3kV Pulsed)
- Safety capacitor: Y2 MLCC (PSK FK21X102K502EGG, 250Vac working, 5kV pulsed)
- Isolated Transformer: PAD001-T764120S (400Vrms working 3.1kV pulsed)

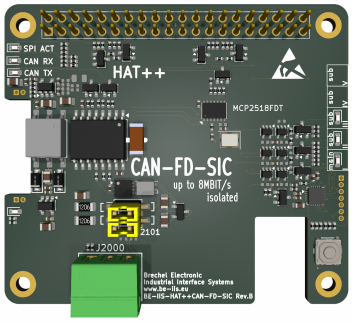
The PCB layout is designed to meet a creepage and clearance distance of 5 mm.

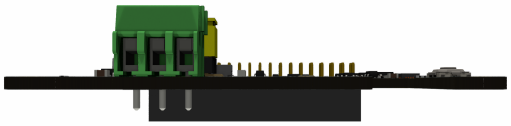
The isolation performance has not been formally validated. Users must evaluate the suitability of the isolation for their specific application. Use of the isolation feature is at the user's own responsibility.

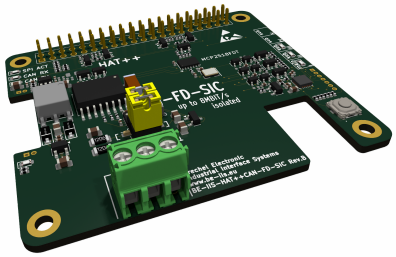
2.5 Connectors

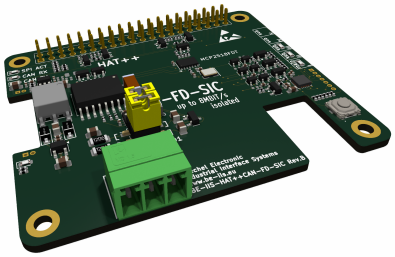
Connectors J2000 provides the physical CAN-FD bus interface. Two commonly used connector options can be populated.











Supplier: Phoenix Contact
MPN: PT 1,5/3-3,5-H
Order Code: 1984620 [4]
Description: 3-pin 3.5 mm screw terminal block
Note: This connector is included in the delivery

Supplier: Phoenix Contact
MPN: MC 1,5/ 3-G-3,5 - PCB header
Order Code: 1844223 [5]
Description: 3-pin 3.5m mm PCB header

2.6 Jumper and Configuration

Jumper JP2101 configures the CAN bus termination.
For proper CAN and CAN-FD operation, termination must only be enabled at the two physical end nodes of the bus segment.
End nodes: Jumper installed (120 Ω termination enabled)
Intermediate nodes: Jumper not installed (termination disabled)
In **point-to-point operation**, both connected devices are considered end nodes. Therefore, termination must be enabled on both nodes (jumper installed on both sides).
Figure 3 shows the jumper configuration. The installed jumpers are highlighted in yellow.

Pin	Signal	Pin	Signal
1	Termination	2	CAN-Low
3	Termination	4	CAN-High

Table 3: JP2101 pin assignment

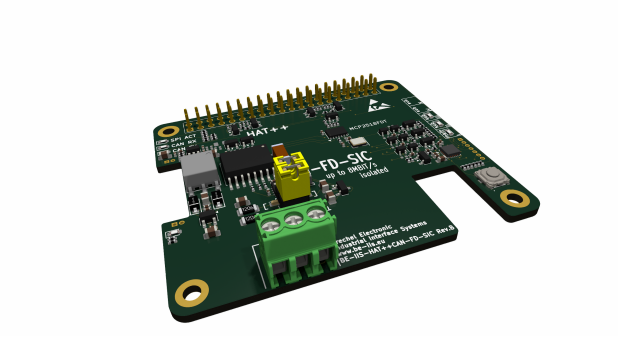


Figure 3: JP2101 termination jumper configuration for CAN/CAN-FD operation. Highlighted jumpers indicate enabled 120 Ω termination at the bus end nodes.

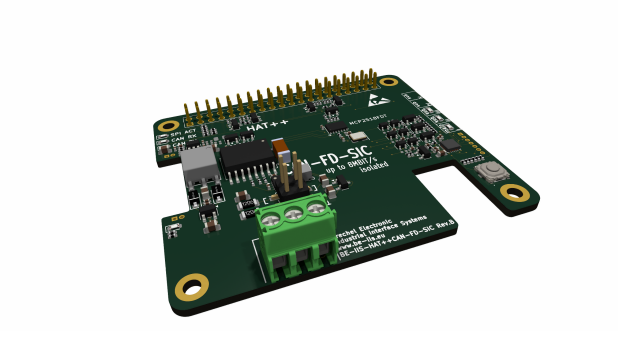


Figure 4: JP2101 jumper configuration for CAN/CAN-FD operation with termination disabled. Open jumpers indicate intermediate node configuration (no 120 Ω termination).

2.7 Indicators (LEDs)

In addition to the LED status bar on the side, which indicates the selected instance mode, there are additional LEDs located on the opposite side of the HAT:

- **SPI ACT**: Indicates active SPI communication
- **CAN RX**: Indicates CAN receive activity
- **CAN TX**: Indicates CAN transmit activity

An additional LED is located on the isolated CAN supply domain. This LED indicates proper operation of the isolated power supply.

2.8 Signal Polarity and Wiring Orientation

The CAN bus interface requires correct signal polarity. CAN_H and CAN_L must be connected to their respective terminals and must not be swapped.

The PCB silkscreen marking indicates the signal assignment:

- Ⓗ: CAN-High

- Ⓛ: CAN-Low
- ⏚: CANGND reference (separated from Raspberry Pi GND)

This applies to normal data communication as well as to bus wiring in industrial setups.

3 Software and System Configuration

The BE-IIS-HAT++ system provides a unified platform for fast system integration.

- Predefined drivers and kernel modules
- Support for prebuilt modules and custom kernel builds
- Ready-to-use build and configuration scripts
- Centralized software repository (see Reference **??**)
- Typical setup time below a few minutes

After installation, the system can be used without further software modification.

4 Electrical Specifications

4.1 Supply Voltage

Parameter	Min	Typ	Max
3.3 V Input [V]	2.7	3.3	3.6
5 V Input [V]	4.5	5	5.5

Table 4: Voltage Supply

4.2 Power Consumption

Parameter	Typ	Unit
Current @ 3.3 V	26	mA
Current @ 5 V	150	mA

Table 5: Current Consumtion

5 Environmental Conditions

5.1 Conditions

Condition	Min	Max
Operating Temperature [°C]	-40	+85
StorageTemperature [°C]	-20	+105
Relative humidity [%]	5	95

Table 6: Operation Conditions

5.2 Usage

Condition	parameter
Usage	indoor
Pullution degree	2
Operating altitude	up to 2000m

Table 7: Operation usage

5.3 EMC and Environmental Compliance (Preliminary)

The standard version of the board is provided without formal EMC or safety certification.

The hardware design is developed with consideration of commonly applied IEC standards, including:

- **ESD immunity:** IEC 61000-4-2
- **Electrical fast transient (EFT/Burst):** IEC 61000-4-4
- **Surge immunity:** IEC 61000-4-5
- **Conducted RF immunity:** IEC 61000-4-6
- **Radiated RF immunity:** IEC 61000-4-3
- **EMC immunity (industrial):** IEC 61000-6-2
- **EMC emission (industrial):** IEC 61000-6-4
- **Safety / isolation reference:** IEC 62368-1

These standards are not verified for the standard product variant.

Compliance with specific standards, test levels, or safety requirements is not guaranteed unless explicitly specified.

If defined EMC or isolation requirements are provided, application-specific validation, testing, and certification can be supported. Upon request, product variants with validated performance, including labeling, certification, and test reports (e.g. Hi-Pot testing), can be delivered.

6 Delivery Condition and Assembly

The product is delivered as a partially assembled kit intended for final user assembly. Mechanical accessories and connector components required for standard evaluation and stacked operation are included.

Order Code	BE-IIS-HPP-CAN-FD-SIC-REV.B
Condition	Assembly kit
Status	Partially assembled
Included Items	1× HAT 4× 15 mm spacers 1× 2×20 pin stackable header 2x Jumper 1x 3-pin skew connector
REACH & RoHS	Compliant with EU Directive 2011/65/EU and REACH Regulation (EC) No 1907/2006

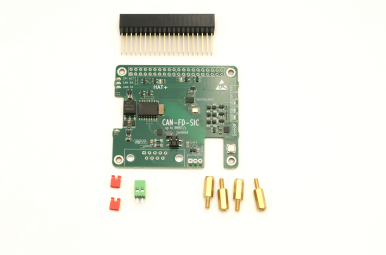


Figure 5: Delivery condition

7 Mechanical

7.1 Board Format

- Form factor: Raspberry Pi HAT+
- Mechanical dimensions: Raspberry Pi HAT compatible [6]
- Mounting hole pattern: Raspberry Pi HAT compatible [6]
- Stackszize: 15mm

7.2 Connectors and Assembly Height

- Host connector: 40-pin Raspberry Pi header
- Field connector: J6000, updated connector option
- Assembly height: [TODO]

7.3 Board Views

Figure 6: Mechanical overview

8 Assembly

This product is delivered as a kit and requires basic soldering and mechanical assembly.

8.1 2x20-Pin Main Connector

The 2x20-pin connector provides the interface to the Raspberry Pi. For proper HAT functionality, the connector must be assembled carefully.

A stackable 2x20-pin header is included in the delivery and is recommended for most applications, especially when using the BE-IIS HAT++ stacking system.

- Mount the header on the top side of the PCB (component side)
- The socket side faces down towards the Raspberry Pi

Alternatively, a standard (non-stackable) pin header may be used if stacking is not required.

Soldering instructions:

- Use a suitable soldering iron with adequate temperature control
- Ensure good ventilation and avoid inhaling solder fumes
- Heat both the pad and the pin simultaneously, then apply solder
- Solder each pin individually and ensure proper wetting
- Avoid excessive solder to prevent large solder cones, which may affect stacking capability

Proper alignment of the connector is important to ensure mechanical compatibility with the Raspberry Pi and other HATs.

8.2 Spacer

To ensure mechanical stability and correct stacking height, spacers must be installed.

- Recommended spacer height: 15 mm
- Fix the PCB using appropriate screws and spacers
- Ensure stable mechanical mounting to avoid stress on the connector

The spacers define the stacking distance and provide mechanical fixation of the HAT.

8.3 3.5 mm Terminal Block Connector

A suitable screw terminal block is typically included in the delivery. Alternatively, a compatible PCB header (plug or socket variant) may be used, depending on the application. Refer to the corresponding product section for supported connector types.

Assembly instructions:

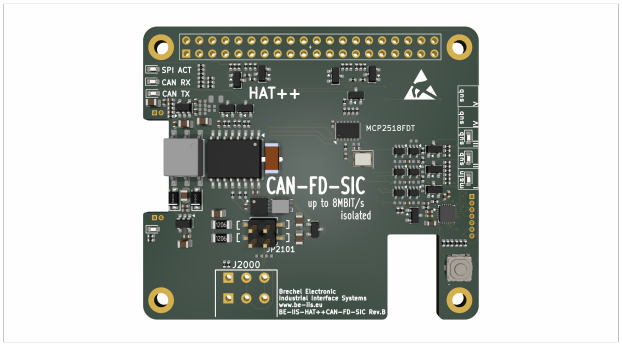
- Ensure correct orientation before soldering: the cable entry openings must face outwards from the PCB edge
- Insert the connector fully into the PCB to ensure proper mechanical alignment
- Solder all pins carefully with sufficient wetting

Important notes:

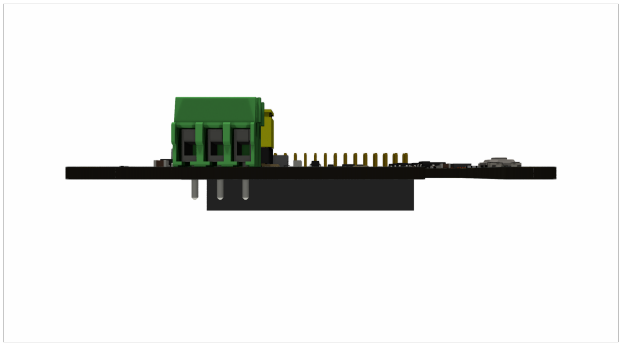
- Avoid direct contact between the soldering iron and the plastic housing of the connector, as this may cause visible damage or deformation
- Ensure clean solder joints without excessive solder to maintain proper mechanical fit

Correct assembly ensures reliable electrical contact and proper usability of the terminal interface.

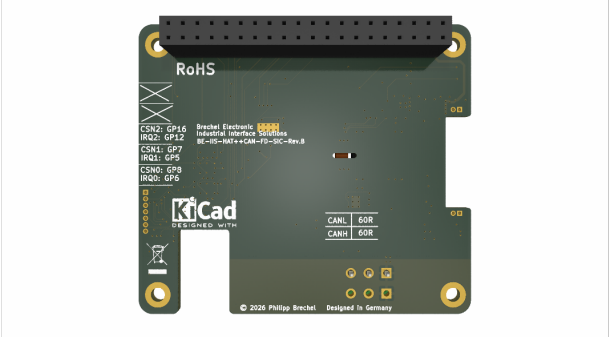
8.4 Board Overview



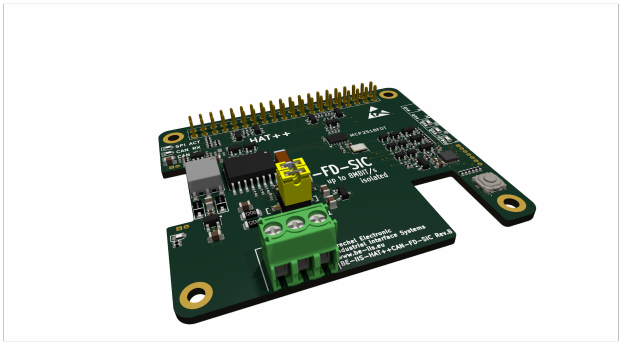
Top view



Front view



Bottom view



Side view

Figure 7: BE-IIS-HAT++CAN-FD-SIC – mechanical overview

9 References

10 References

1. Microchip MCP2518FD product page
2. Texas Instruments TCAN1472-Q1 product page
3. BE-IIS Installer (Software and Setup Tools)
4. PhoenixContact PT 1,5/ 3-3,5-H - PCB terminal block
5. PhoenixContact MC 1,5/ 3-G-3,5 - PCB header
6. Raspberry Pi HAT+ Specification
7. PCB layout and assembly documentation

11 Revision History

Revision	Date	Description
A.00	2026-02-12	Initial draft
A.01	2026-02-12	Electrical and connector data added
A.02	2026-02-12	Content migrated from earlier T1S draft and revised for CAN-FD-SIC
A.03	2026-03-31	version2