

ABSTRACT

The ULC-HPB-DEMO is a complete demo system capable of demonstrating Ultrasonic Lens Cleaning (ULC) technology. The demo is jointly developed by Texas Instruments and [HPB Optoelectronics](#). The construction of the demonstration kit is completed by [HPB Optoelectronics](#).

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1 General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

Always follow TI's setup and application instructions, including use of all interface components within the recommended electrical rated voltage and power limits. Always use electrical safety precautions to help maintain your personal safety and those working around you. Contact TI's Product Information Center <http://ticsc.service-now.com> for further information.

Save all warnings and instructions for future reference.

WARNING

Failure to follow warnings and instructions can result in personal injury, property damage, or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open-framed unenclosed printed circuit board assembly. The TI HV EVM is intended strictly for use in development laboratory environments, solely for qualified professional users who have training, expertise, and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use or application are strictly prohibited by Texas Instruments. If the user is not qualified, then immediately halt further use of the HV EVM.

1. 1. Work Area Safety a. Keep work area clean and orderly.
 - a. Qualified observers must be present anytime circuits are energized.
 - b. Effective barriers and signage must be present in the area where the TI HV EVM and the interface electronics are energized. For the purpose of protecting inadvertent access, these signs must indicate operation of accessible high voltages can be present.
 - c. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 Vrms / 75 VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
 - d. Use stable and non-conductive work surface.
 - e. Use adequately insulated clamps and wires to attach measurement probes and instruments. No free-hand testing whenever possible.
2. Electrical Safety: As a precautionary measure, a good engineering practice is to assume that the entire EVM has fully accessible and active high voltages.
 - a. De-energize the TI HV EVM and all the inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Confirm that the TI HV EVM power has been safely de-energized.
 - b. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment connection, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
 - c. After EVM readiness is complete, energize the EVM as intended.

WARNING

WARNING ELECTRICAL SHOCK HAZARD.

WHILE THE EVM IS ENERGIZED, NEVER TOUCH THE EVM OR THE ELECTRICAL CIRCUITS BECAUSE THERE CAN BE HIGH VOLTAGES CAPABLE OF CAUSING ELECTRICAL SHOCK HAZARD.

3. Personal Safety: Wear personal protective equipment (for example, voltage rated gloves or safety glasses with side shields) or protect the EVM in an adequate protective closure with interlocks to protect from accidental touch.
4. Limitation for safe use: EVMs are not to be used as all or part of a production unit.

2 Introduction

The ULC-HPB-DEMO is a collaboration between Texas Instruments and [HPB Optoelectronics](#) to create an all-in-one evaluation system for ultrasonic lens cleaning (ULC). Also known as the Executive Demo, this demo is simple enough to operate out-of-the-box without specialized software or additional hardware. The integrated 2 MP camera utilizes the USB video class (UVC) standard to offer a truly plug-and-play experience. The included button module with LED status indicator offers a simple way to evaluate water cleaning, de-icing, and auto sensing. The system uses standard USB-A and USB-C connections that can be extended for different testing environments.



Figure 2-1. ULC-HPB-DEMO Configured

3 Hardware Overview

The following hardware is included in the box:

- 2 MP camera module providing 115° field of view with a 14 mm Instant Clear View System (ICVS)
- 4-button control box
- 12-V power supply
- Micro-USB to USB-A cable
- USB-C cable
- Barrel jack adapter
- Mini spray bottle
- Quick start guide



Figure 3-1. ULC-HPB-DEMO Box Contents

4 What's in the Box

The [Camera Module](#) contains three circuit boards. From front to back, these boards are the camera module, the driver board, and a connector board for passing all signals. The device has two ports on the back: one Micro-USB for the camera and one USB-C for passing power and Inter-Integrated Circuit (I2C) communication to the driver board. The Micro-USB can optionally be connected to a Windows 10 PC. ULC-HPB-DEMO can run on the native Windows Camera app without downloading and installing additional software. The USB-C needs to be connected to the [Switch Box](#).



Figure 4-1. Camera Module

The switch box controls the ultrasonic lens cleaning in the camera module. The barrel jack plugs into the supplied switching adapter. The USB-C output plugs into the camera module.

WARNING



All high voltage is enclosed in the camera module.



Figure 4-2. Switch Box

The additional hardware includes:

1. Switching power supply, 36W power adapter accepts 110-240 VAC 50/60 Hz
2. USB-C Cable - connects the [Camera Module](#) and the [Switch Box](#)
3. Barrel jack adapter for the power supply
4. USB-A to Micro USB-B Cable
5. Empty spray bottle



Figure 4-3. Additional Hardware

5 Getting Started

Please follow this order for connecting and setting up ULC-HPB-DEMO. To operate without viewing the camera, skip steps 2 and 3:

1. Fill spray bottle with water.
2. Connect Micro-USB cable from computer to [Camera Module](#).
3. Open native windows camera app on computer by clicking on search and type "camera".
4. Connect USB-C cable from [Camera Module](#) to [Switch Box](#).
5. Connect 1.5" power supply adapter onto power supply cable.
6. Plug power supply into 110-240 VAC wall outlet.
7. Connect adapter into [Switch Box](#). System powers up, calibrates, and initializes camera box.
8. Once completed, LED light is solid blue, the unit is ready to take push button commands.
9. For cleaning commands, see the [Button Functions](#).



[Table 5-1](#) describes the push button commands. Any mode can be stopped by pressing any button while the mode is running.

Table 5-1. Buttons Function

Label	Button Press	Description
W	Short	Runs one water cleaning sequence.
A	Short	Enables auto sense mode. Begins by completing a new calibration sequence. Wait 6 seconds after button press to spray water onto lens. Runs until another button press.
C	Short	Enables continuous water mode. Runs until another button press.
I	Short	Runs de-ice sequence (40 seconds heating and expulsion).
	Long (3-seconds)	Runs de-fog sequence (20 seconds heating).
A+W	Long (3-seconds)	Runs calibration sequence. Can be run when system is not cleaning well.

6 LED Status Indicator

The [Switch Box](#) LED illuminates according to the following status:

- **Solid** Ready to receive command
- **Slow flashing** Operating
- **Fast flashing** Writing, calibrating, or pre-processing of auto mode

Over temperature is a possible flag that can occur in the ULC-HPB-DEMO. This flag initiates a cooling state that checks the temperature every second until the demo reaches a temperature in the operable range. In de-ice or de-fog mode, this flag can make the runtime longer than the declared time.

7 Schematics

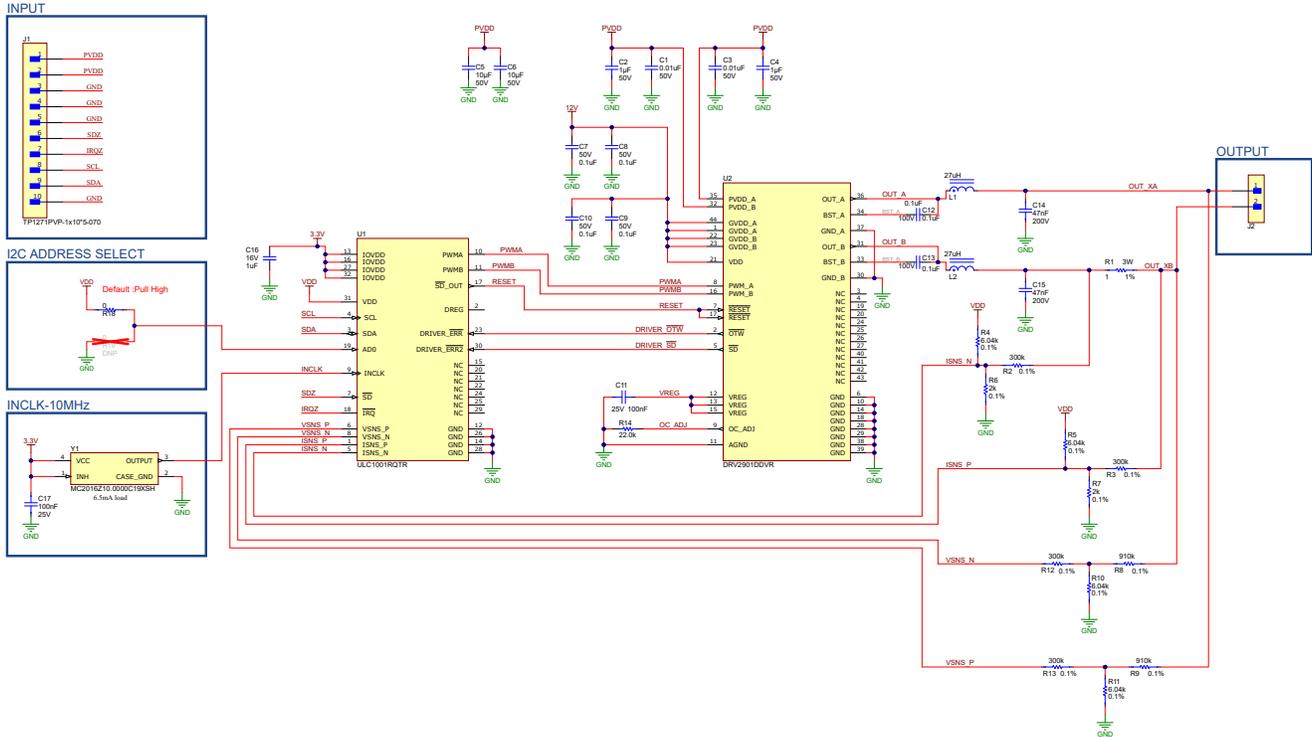
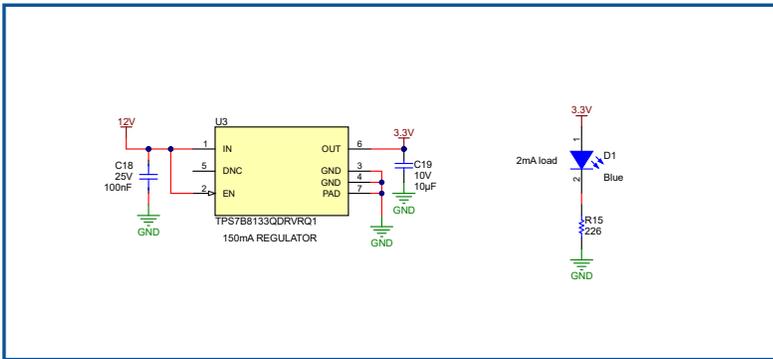


Figure 7-1. ULC-HPB-DEMO Schematic (Sheet 1 of 2)

3.3V Buck (Supports 3.5V-40V Input)



12V LDO (Input from Boost)

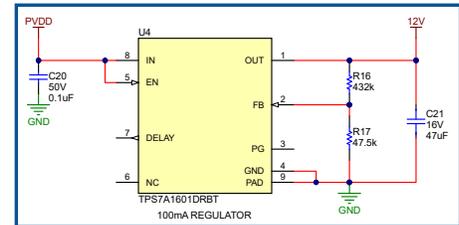


Figure 7-2. ULC-HPB-DEMO Schematic (Sheet 2 of 2)

8 Layout

- Compact 26mm X 28mm PCB
- TI Content:
 - ULC1001 - Ultrasonic DSP Controller
 - DRV2901 - Class D Amplifier
 - TPS7B8133 - 3.3V LDO
 - TPS7A1601 - 12V LDO

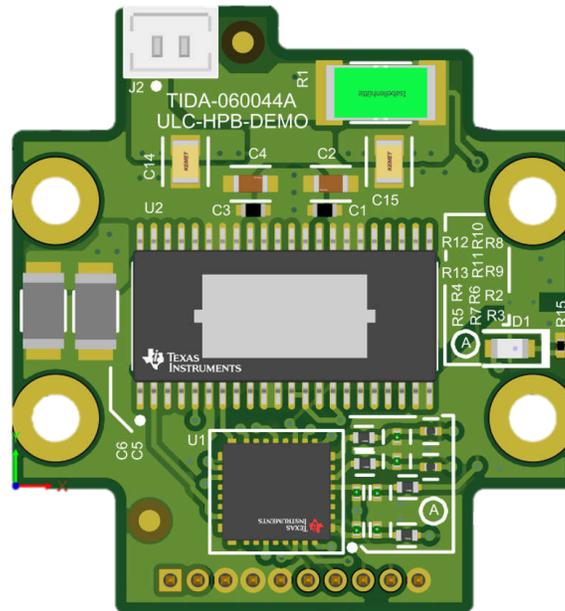


Figure 8-1. PCB Front

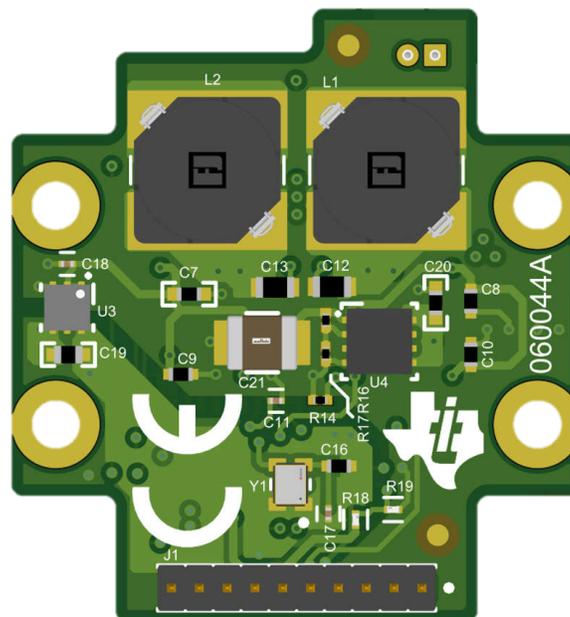


Figure 8-2. PCB Back

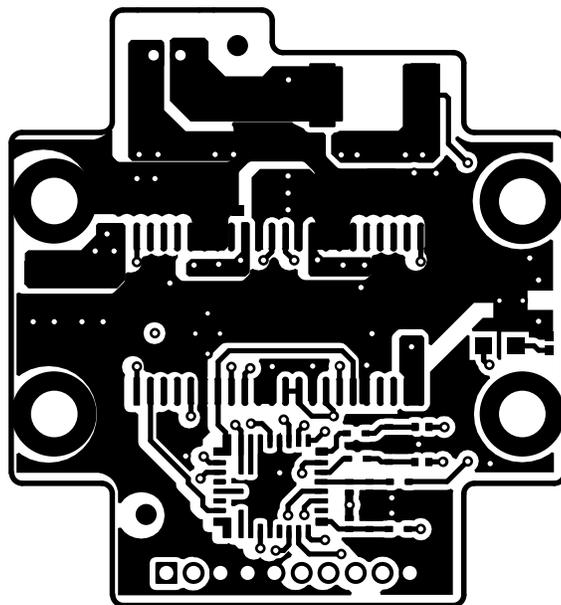


Figure 8-3. Top Layer

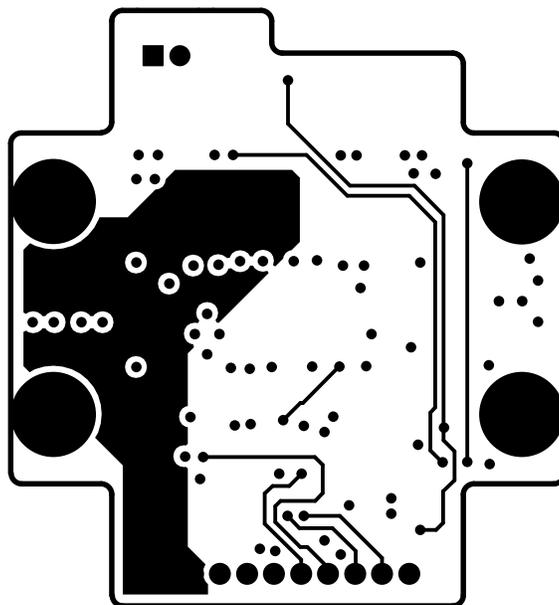


Figure 8-4. Signal Layer 1

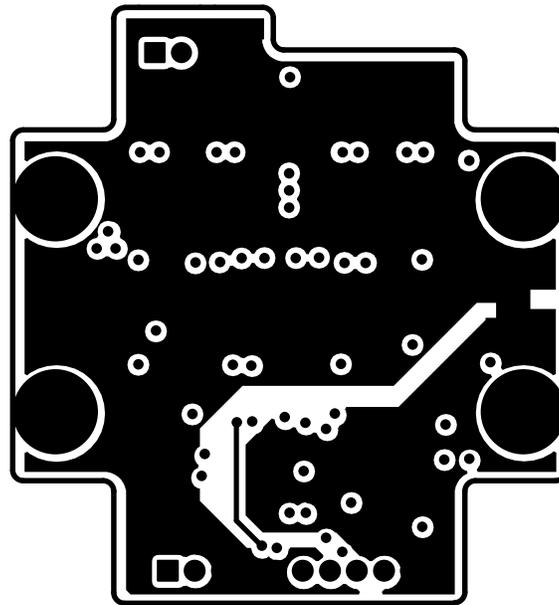


Figure 8-5. Signal Layer 2

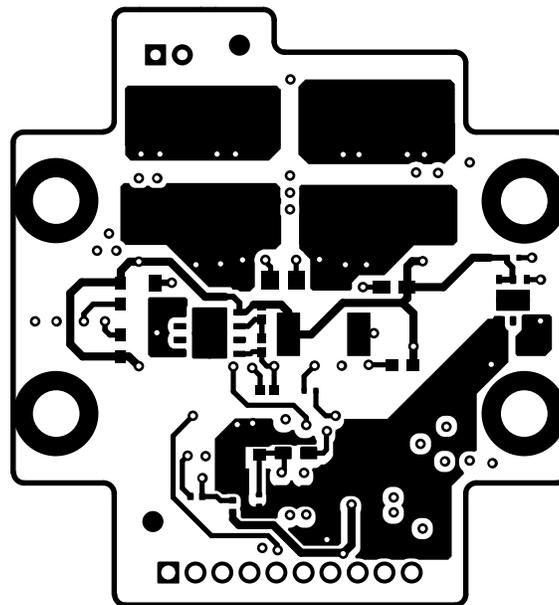


Figure 8-6. Bottom Layer

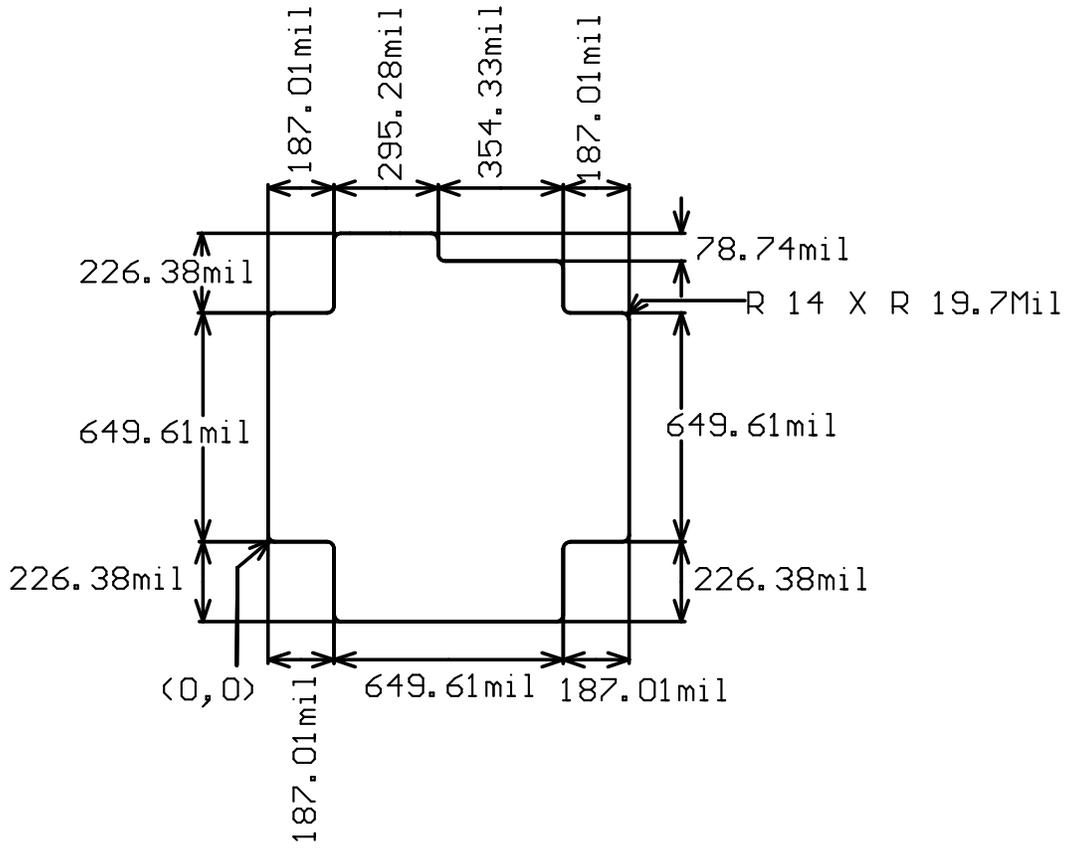


Figure 8-7. Board Dimensions

9 Dimensions

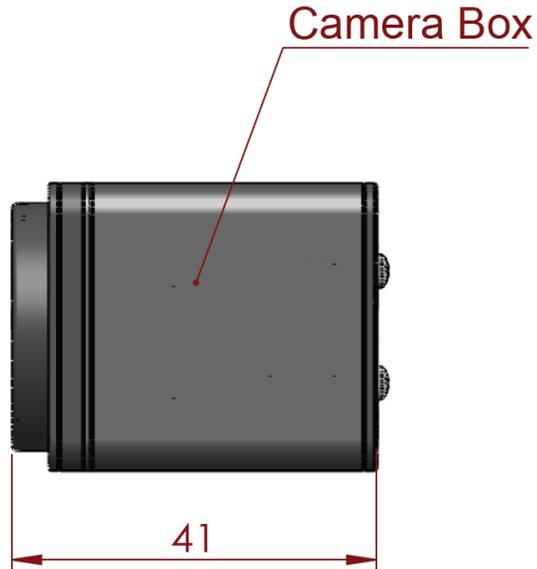


Figure 9-1. Camera Box Side Dimensions (mm)

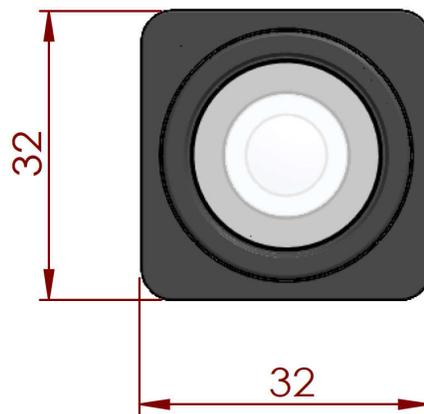


Figure 9-2. Camera Box Front Dimensions (mm)

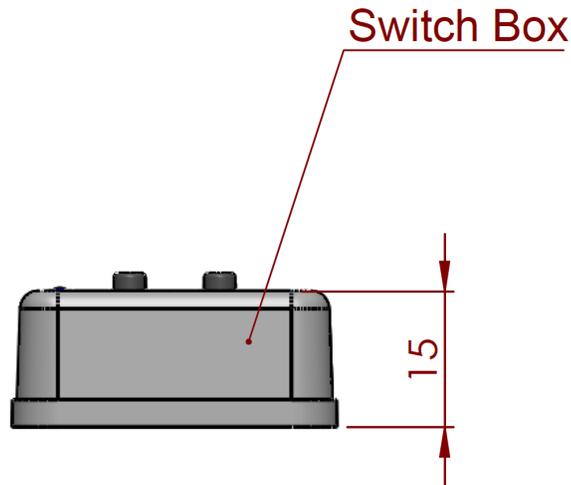


Figure 9-3. Switch Box Side Dimensions (mm)

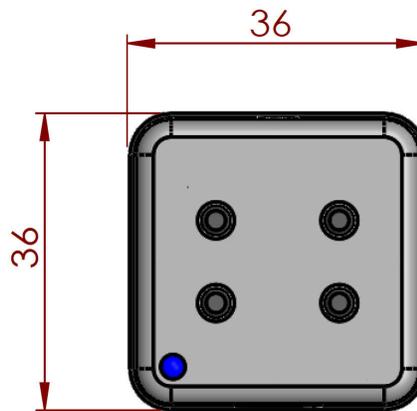


Figure 9-4. Switch Box Top Dimensions (mm)

10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (September 2023) to Revision A (December 2023)	Page
• Updated Section 9	12

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