CH-101 Mechanical Integration Guide

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Document Number: AN-000158
Revision: 1.0
Release Date: 08/28/2019

1 INTRODUCTION

The ICP-10104 pressure sensor family is based on MEMS capacitive technology which provides ultra-low noise at the lowest power, The design of the acoustic opening that interfaces with the CH-101 port is critical to achieve the maximum sensitivity and bandwidth of the sensor. This document provides the dimensions required to achieve optimum performance and gives recommendations on the mechanical integration of the CH-101 sensor into customer's product enclosures.

For circuit integration of the sensor, consult the Transceiver Spec document. For guidelines on handling the part, consult the Handling and Assembly Notes document. For guidelines on system level testing, consult the System Level Testing Guide.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

No table of figures entries found.

2 PORT OPENING AND ALIGNMENT TOLERENCES

Error! Reference source not found. shows the principal dimensions of the CH-101 package and the location and dimension of the acoustic port. For a more detailed drawing and tolerances, see **Error! Reference source not found.**.

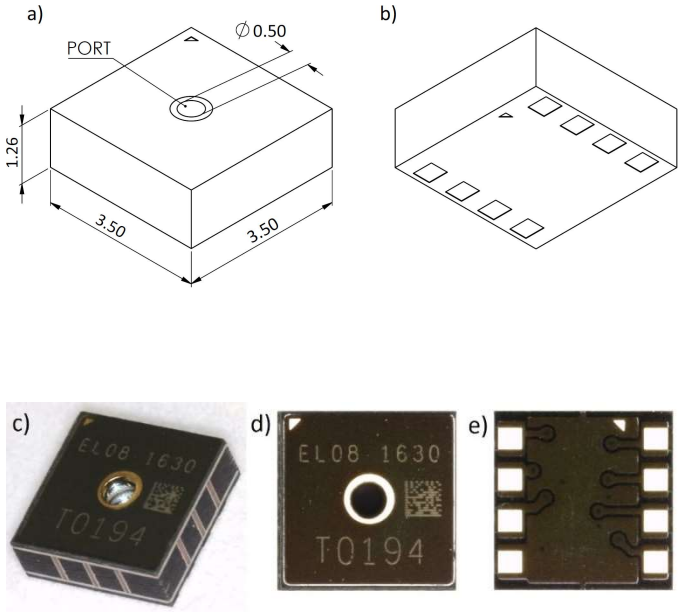

Figure 1. CH-101 dimension drawings (a & b) and photographs (c, d, & e)

The CH-101 is an ultrasonic transceiver that is used to transmit and/or receive ultrasonic signals at a fixed frequency. As with MEMS microphones, the CH-101 requires an opening (port) in the application enclosure to allow sound to exit to or enter from the surrounding environment. However, unlike MEMS microphones, the shape and dimensions of the enclosure port are critical to device performance. The package outline with dimensional tolerances is shown in **Error! Reference source not found.**.

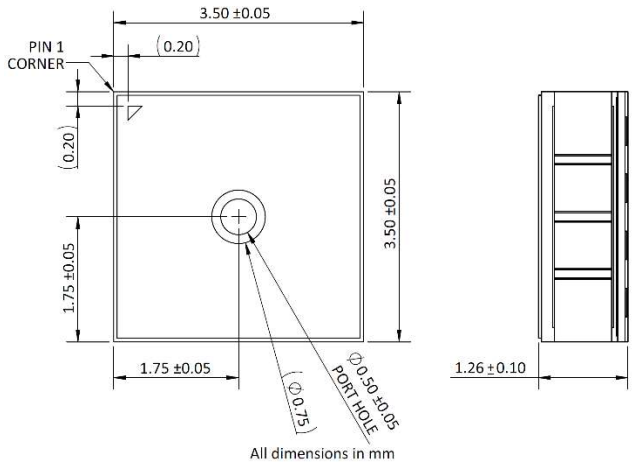

Figure 2. Package outline drawing with tolerances

The enclosure port must be a hole of constant diameter 0.7 ±0.05 mm and length 0.475 ±0.05 mm if no protective membrane is used in the application (otherwise, refer to Section "**Error! Reference source not found.**"). The enclosure port center must be 1.75 ±0.1 mm from the specified reference corner of the CH-101 in both x- and y-direction as shown in **Error! Reference source not found.**.

Other shapes of the enclosure opening are not recommended due to the resultant loss of performance. Please contact Chirp Microsystems for a more detailed review of the design of the enclosure port when you are ready to begin your prototyping project.

A flexible gasket does not need to be used between the CH-101 and the product enclosure if the enclosure's mating wall is sufficiently flat. If a gasket is to be used, the opening in the gasket must have the same diameter as the enclosure port and the gasket's thickness must be subtracted from the enclosure wall thickness to ensure no impact on the acoustic performance.

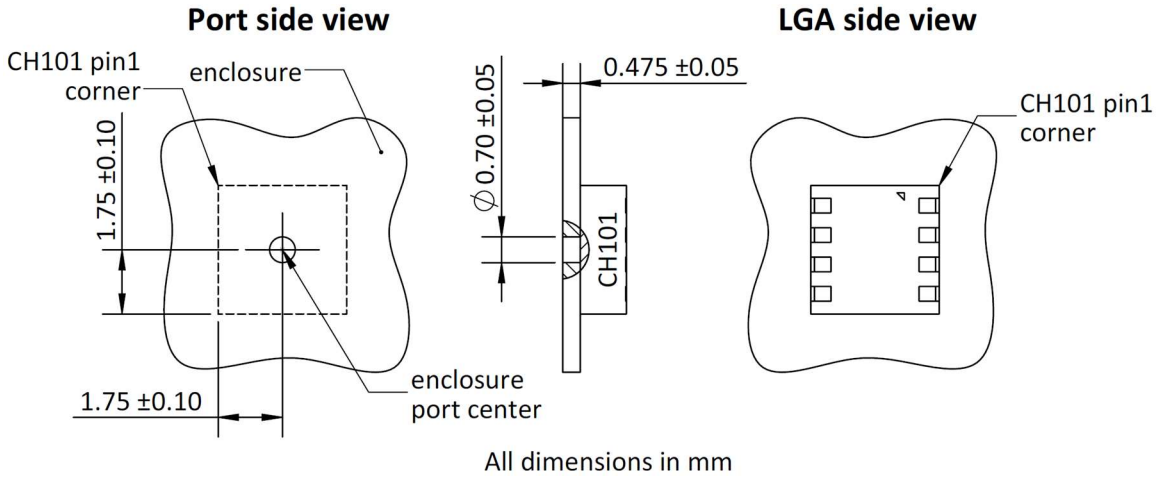

Figure 3. Schematic view of the required dimensions and tolerances of enclosure port and its location relative to the reference corner of device

3 RECOMMENDED PORT ALIGNMENT METHODS

Alignment of the CH-101 port to the enclosure port can be achieved in various ways. One method is mechanical alignment of the CH-101 package to a slightly oversized square cavity in the product enclosure as shown in **Error! Reference source not found.**.

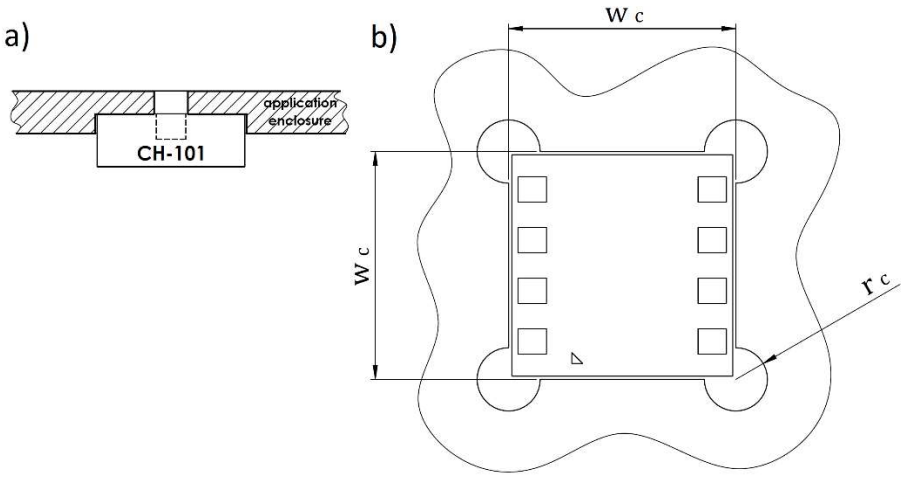

Figure 4. Cavity in the product enclosure for alignment of the CH-101 ort to enclosure port shown in a) cross-section and b) bottom view

This method requires excellent control of the enclosure port centering to the cavity center and accurate sizing of the cavity as a square with side length w_c=3.6±0.05 mm. Circular corner cutouts with an appropriate radius (e.g., r_c=0.5 mm) as shown in the figure should be used to ensure proper fitting of the transducer into the cavity.

The CH-101 can also be visually aligned to the product enclosure from outside the enclosure as shown in Figure 5. This alignment method is possible because the CH-101 port is smaller than the enclosure port and thus visible through the enclosure port.

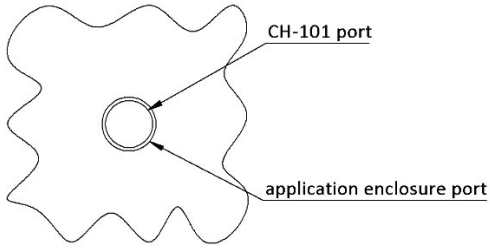

Figure 5. Visual alignment of the CH-101 port to the product enclosure port

4 RECOMMENDED PORT ALIGNMENT METHODS

The recommended attachment method for the CH-101 to the product enclosure is shown in Figure 6. A liquid adhesive can be applied outside the transceiver. Care must be taken to ensure that the liquid adhesive does not enter the CH-101 port.

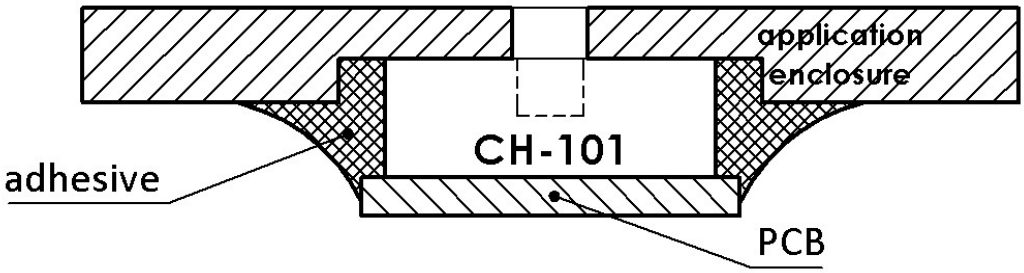

Figure 6. CH-101 attachment to product enclosure using liquid adhesive

Alternatively, a pressure sensitive adhesive (PSA) sheet can be used in between the CH-101 and the product enclosure as shown in **Error! Reference source not found.**. The opening in the PSA layer must have approximately the same diameter as the enclosure port. The PSA thickness must be subtracted from the enclosure wall thickness such that the total thickness of the enclosure wall plus the adhesive equals l_p to ensure no reduction of acoustic performance.

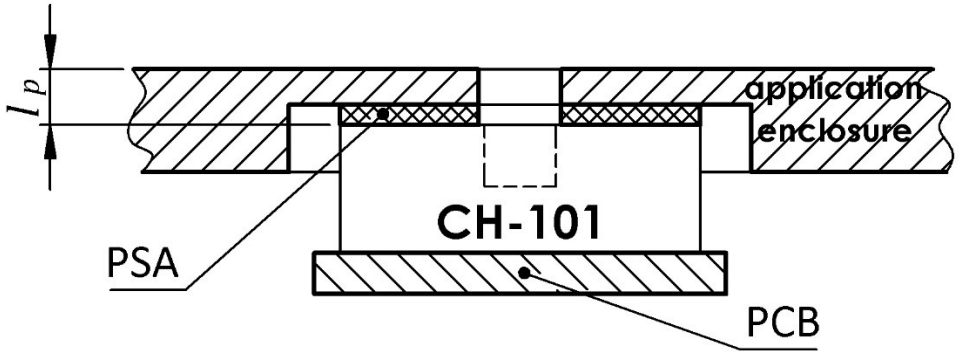

Figure 7. CH-101 attachment to product enclosure using liquid adhesive

5 RECOMMENDATIONS FOR USE OF PROTECTIVE MEMBRANE

It is recommended that a protective membrane is used if dust or contaminants from the application environment could enter the acoustic port. The only membrane material currently supported by Chirp is SAATI Acoustex 042. The membrane must be placed on the outside of the application enclosure without any gap as shown in Figure 8. When using a membrane, the enclosure port length must be changed to 0.40 ±0.05 mm while the diameter of 0.7 ±0.05 mm is equal to the case without membrane. Please contact Chirp for additional information on using protective membranes with CH-101 devices.

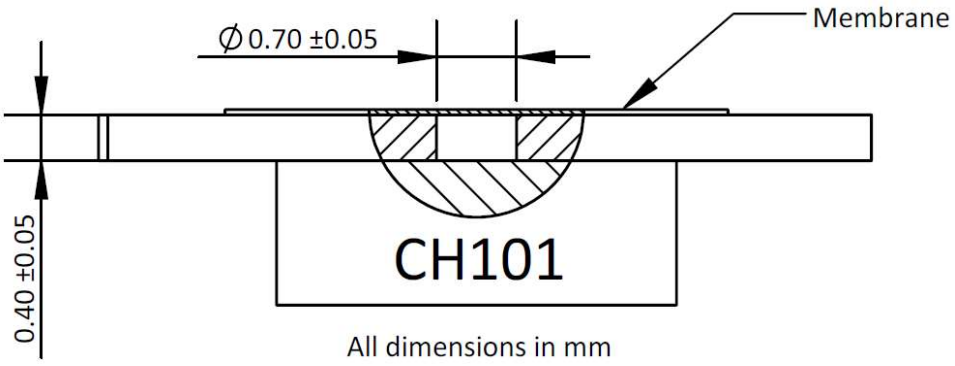

Figure 8. Schematic view showing the placement of a protective membrane as well as the required enclosure port dimensions and tolerances for this case

6 BEST PRACTICES FOR ACOUSTIC PERFORMANCE

Good acoustic design of the enclosure near the port is critical for good performance of the CH-101 transceiver. The sound wave emitting from the enclosure port is omnidirectional as shown in Figure 9a. Poor acoustic design can have several negative effects including reduced field of view, reduced signal intensity (resulting in lower SNR and thus shorter max range), and multipath phenomena (e.g., incorrect range measurement). Figure 9b, c, and d show scenarios of desirable and undesirable acoustic designs.

In Figure 9b, the CH-101 port is placed close to the edge of the product enclosure. If sharp corners must be used, the CH-101 port should be >20 mm from the edge of the enclosure. If rounded corners (>4 mm radius) are used, the CH-101 port can be placed as close to the edge of the enclosure as desired.

In Figure 9c, the CH-101 port is placed close to a reflecting surface, which will severely impact the performance of CH-101. Reflecting surfaces should be more than 200 mm away from the CH-101 port. In some cases, reflecting surfaces located less than 200 mm away may still result in adequate performance depending on the exact size and geometry of the reflector. System level testing should be performed to determine the impact of nearby reflecting surfaces.

It is important to note that the acoustic wavelength emitted by CH-101 is approximately 2 mm. Protrusions, recessions, slots, and other small features on the surface of the enclosure larger than 0.2 mm can cause unwanted reflections potentially resulting in multipath effects. These features should be rounded or eliminated to achieve optimal performance for your design.

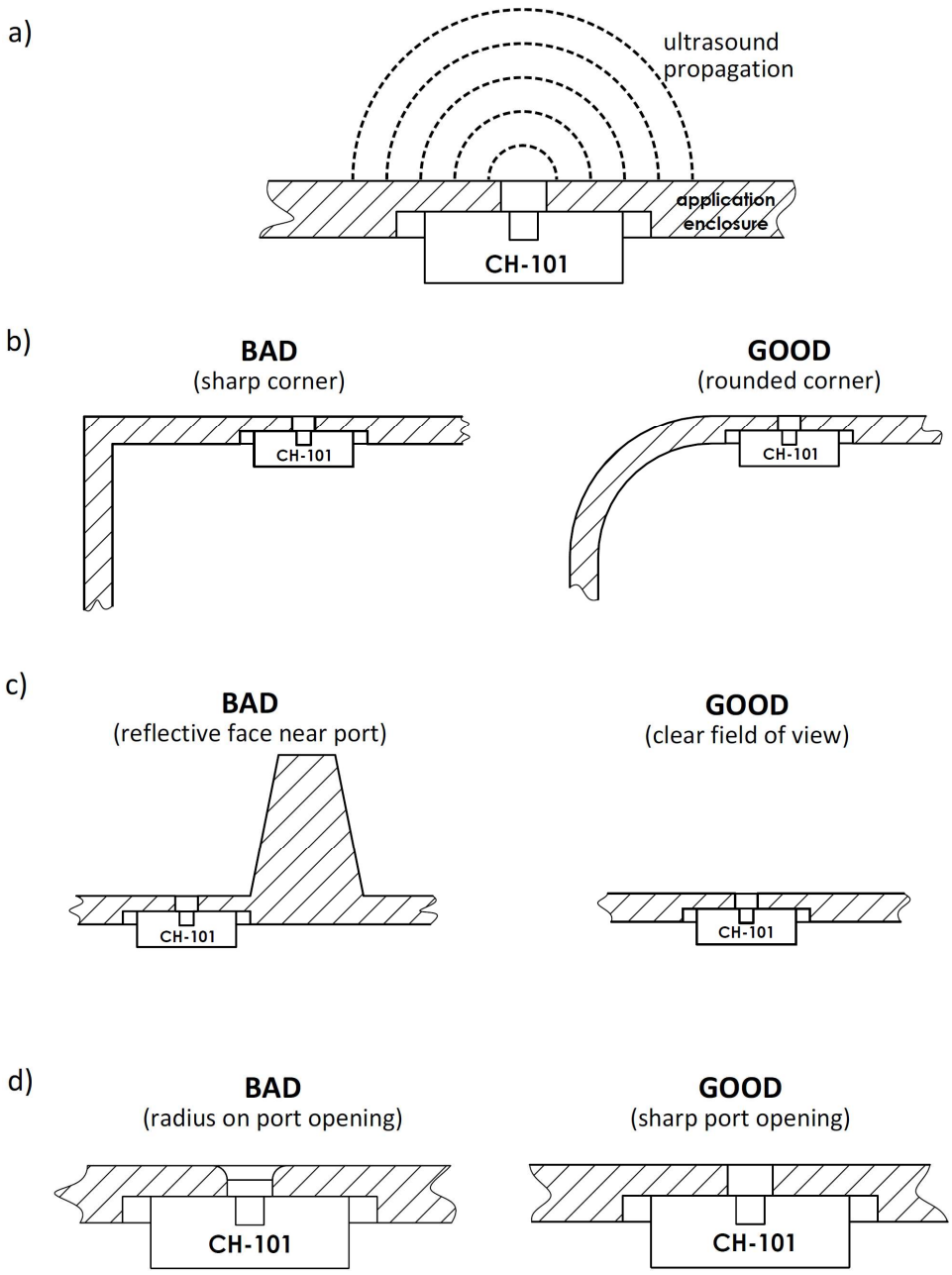

Figure 9. a) Illustration of ultrasound propagation, b), c) & d) examples of bad and good enclosure features

7 MATERIAL CONSIDERATIONS

All hard, solid materials are good reflectors for ultrasound and can thus be used for the product enclosure where the acoustic port is located. Some soft materials, such as open-cell foam, fabrics and furs, are good absorbers of ultrasound and should not be used to form the enclosure port. These materials can, however, be applied to other sections of the application enclosure to reduce unwanted reflections off the enclosure.

8 MULTIPLE TRANSCEIVER PLACEMENT

There is no general restriction on the minimum distance between any two adjacent CH-101 transceivers However, to avoid interference effects, when two transceivers are within the max operating range of each other, only one transceiver should be used to transmit ultrasound at any time, and there must be sufficient time between each transmission to ensure all signal reflections are sufficiently attenuated. There is no restriction on the number of transceivers operating simultaneously in receive mode.

9 REVISION HISTORY

Revision Date	Revision	Description
8/28/2019	1.0	Initial Release