Mechanical Application Paper: Densitron Haptic Touch Screen

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Version 2.1

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1. Introduction

Immersion's TouchSense® technology enables haptic feedback for touchscreens, touch surfaces, and buttons.

Haptic feedback, also known as tactile feedback, touch feedback, and vibro-tactile feedback, allows for a more intuitive, engaging, and natural experience for the user. Haptics can improve the user interface by:

- Making onscreen buttons feel like they press and release
- Improving the usability of sliders, scrolling lists, and list end stops
- Providing attention-getting tactile components for alarms and error conditions

TouchSense tactile sensations combine well with audio feedback and graphics to create a more immersive, complete, and intuitive multisensory experience.

Densitron has partnered with Immersion to provide a Haptically enabled 5.7" capacitive touch screen solution. This application paper is intended to help your design team incorpate into your product.

Refer to the document *TouchSense – 2000 Series Mechanical Integration Design Guide: Floating Screen Haptics* for general information, FAQ's and general design guidelines for implementing Haptics.

Refer to the document *TouchSense – 2000 Series Electrical Integration Design Guide: Floating Screen Haptics* for general information regarding the electrical and software requirements for implementing Haptics.

All Design guides and documentation mentioned above is propriatery information of Immerison Corp and can be order directly from Immersion.

2. Haptic System Integration

This section describes general process and design decisions required to integrate TouchSense tactile feedback into Denistron's 5.7in touch screen display. Although several solutions exists, the integration outlined in this application paper is recommended and is based off a testing results performed by Immersion. Please contact your Immersion account representative if your requirements are not supported by this guide.

2.1 Mechanical Integration – Haptic Suspension Design

2.1.1 Overview

The haptic suspension recommended for Denistron's 5.7" capacitive touch screen consists of the touch screen, a carrier that attaches to the touch screen, and a plurality of specialized grommets to allow the touch screen and carrier to float.

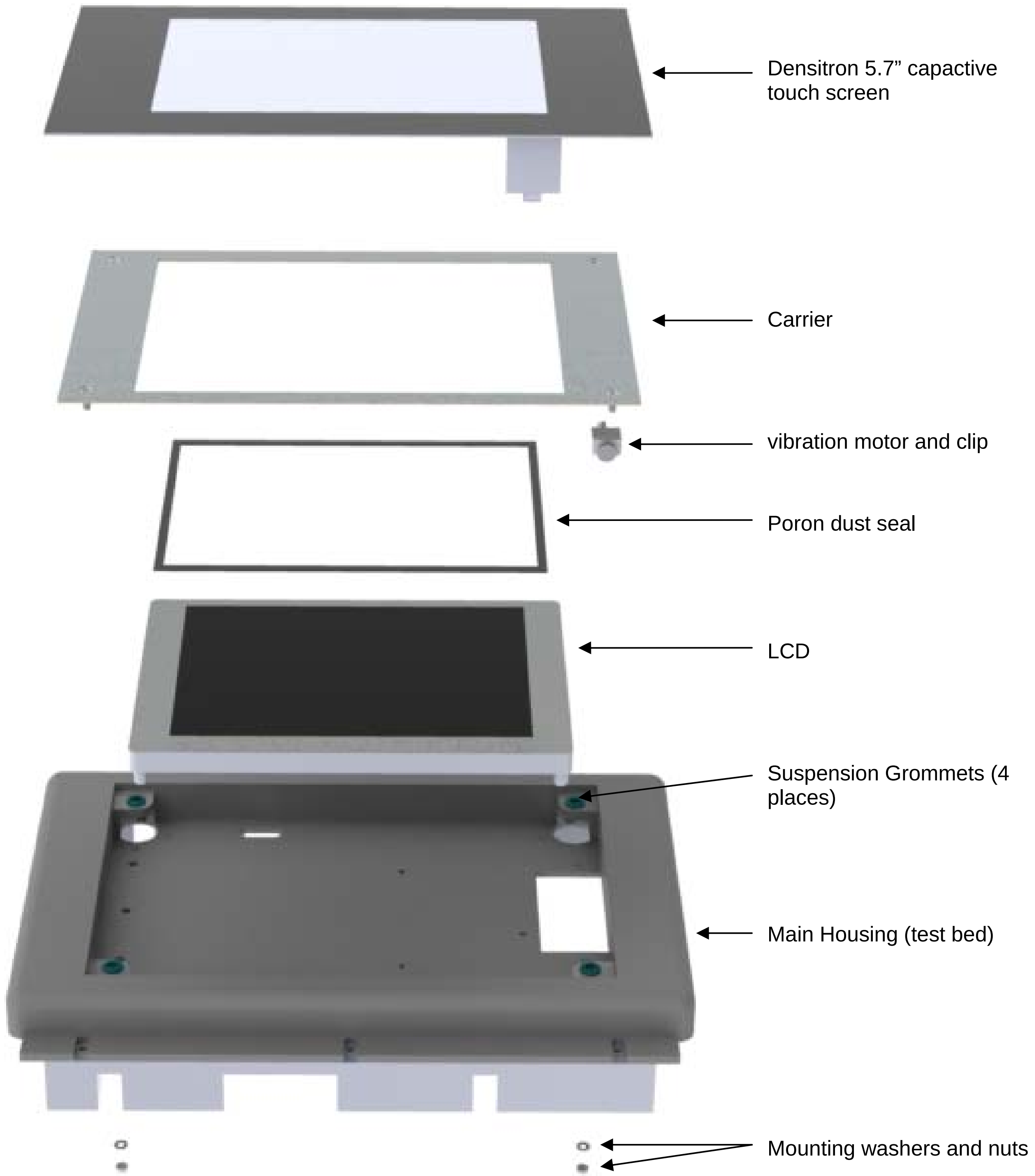
The grommets are installed into the main housing component (i.e. the non moving component). The LCD is also fixed to the main housing component.

The carrier is designed with 4 mounting posts that protrude thru the grommets. The grommets allow the screen to have the required compliance for haptic feedback. Washers and nuts are installed on the bottom of the grommet to prevent the touch screen from becoming separated from the main housing component.

Between the LCD and touch screen, a 2-3mm wide foam seal is installed to prevent dust intrusion between the touch screen and LCD.

The vibration motor that creates the haptic feedback is installed on the carrier, in the upper left corner.

Below is an exploded view illustrating the different components. This reference design was constructed for testing purposes.



Exploded View - 5.7” Reference Design Test Bed

2.1.2 Actuator Selection, Mounting and Location

The **6mm Jinlong vibration motor (model #Z6DL2A017000B)** was selected based on motor performance and measured foating mass. See Appendix A for motor details. This motor provides that best haptic performance for the given touch surface, based on an actuated mass of approximately **68g**.

Contact Densitron for sample quantities and volume order purchasing information.

Based on preliminary testing of Densitron touch surface, it was determined that the upper corner of the display provided the best haptic playback. See Appendix A for exact motor position location.

The preliminary tests found that motor location and orientation influences the haptic playback. It is critical to ensure that the motor position is per the illustration.

The motor is installed into a custom motor mounting clip. See Appendix A for details of clip. Prior to installing the motor, a small amount of cynoacrylate is applied to ensure a rigid connection between the motor and clip. The clip provides a flat surface for better bondng to the carrier.

The clip can be bonded to the carrier via high strength epoxy or industrial grade cynoacrylate.

Location of ERM motor

Your haptic suspension should maintain a minimum of 1 mm clearance between the actuator body and any other component in your design (in particular, the LCD and plastic housing).

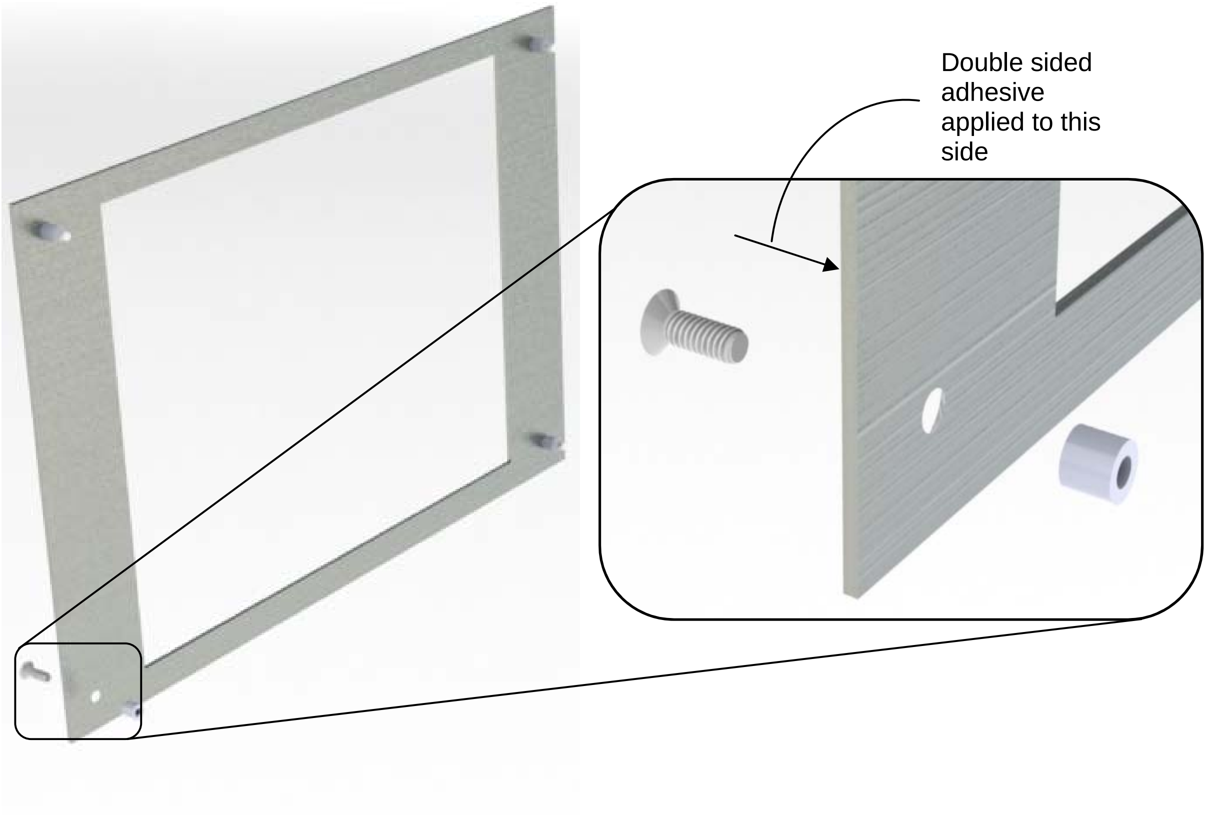
2.1.3 Carrier Design

See Appendix A for a carrier referece design specifics used in the test bed. Key design considerations include:

- Ensuring there is enough clearance between the inside edges of the carrier and the sensing portion of the touch screen to prevent interfence with the touch sensing
- Adequate thickness to provide additional stiffness to the glass
- Providing a flush surface to apply double sided adhesive
- Designing a custom shoulder with 3.5mm diameter to match the grommet inside diameter.
- Designing the shoulder with enough length to allow 0-10% compression of the foam.
- Designing the shoulder with adequate fastening method to ensure that the carrier can be held captive with respect to the grommet and main housing.

Due to the need of a custom post and carrier thickness, the test bed uses a #2 flat head screw (100deg flat head), and an FDM printed post. The screw is installed from the back side and the post is threaded onto the screw, securing the screw in place. Once the carrier is installed, flat washers and nuts are used to hold the touch screen captive, relative to the main housing. See appendix A for screw specification reference and detail on post (designed with aluminum).

3M 468MP is the double sided adhesive used between the carrier and touch screen. Use care to ensure that the carrier aligns with the touch screen when secured in place. See Appendix A for details.



Carrier Assembly- Detail of Grommet Posts

Note that this is just one solution using Alumimun. Design teams may consider using a threaded standoff and screw for mechanically securing the carrier to the housing.

Alternatively, design teams may want to consider designing a plastic part with adequate stiffening features to minimize flex, required bosses for the grommet, and even incorporating the motor clip.

2.1.4 Suspension Grommets

The grommet used for this reference design is a custom design that is optimized for haptics. This grommet is made of a proprietary Isoloss dampening material. This material helps to optimize resonsance during haptic playback and minimize vibration losses.

The grommets should be installed into the main housing prior to installing the touch screen/carrier.

Contact Denistron for sample quantities and volume purchasing information.

Suspension Grommet

2.1.5 Dust Seal Design

The dust seal is comprised of Poron Urethane soft seal foam, series 4701-15-06039, 3mm wide, around entire viewable area. The dust seal has double sided adhesive on one side and is applied to the LCD.

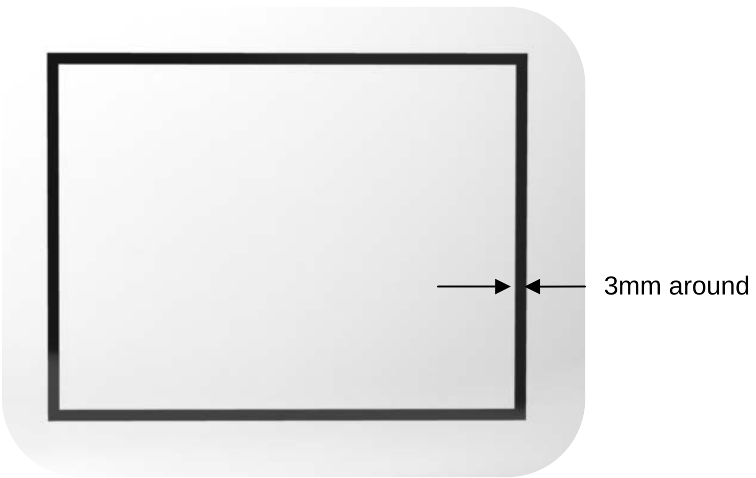


Illustration of Poron Dust Seal

The dust seal should maintain 20-30% compression at all times to prevent dust ingress between the display and touch screen.

The dust seal can be comprised of a single piece, or strips. Contact your local Rogers Corp. (http://www.rogerscorp.com/)representative for sample foam material.

Production design and manufacturing implementation should be determined by the production design team.

2.1.6 Main Housing Design Considerations

The main housing illustrated in section 2.1.1 is not intended to be the final reference design. The following considerations should be made when designing the housing:

- Does the housing allow for a **minimum clearance of .5mm around the perimeter of the touch screen**?
- Did you use the correct cutout dimensions for the grommet?
- Is the feature that includes the grommet cutout stiff enough?
- Do you have adequate access for tweezers and tools to install washers and nuts to secure the carrier?
- Did you account for 0-10% compression of the grommet?
- Did you account for the 20-30% compression of the sealing foam when locating the LCD and touch screen?
- Are the required cutouts for wires and cables in place?
- Do you have the correct clearances for the motor and motor clip?

Top Housing

2.1.7 Reference Design Haptic Performance

The Haptic performance of this reference design was quantified by taking acceleration measurements during an effect playback at different locations on the screen. In general, accelerations range between 1.5-8G's, depending on type of effect, location on screen, and type of implementation.

Using Immersion's Haptic Performance Kit (Immersion p/n TS-ACC-KIT) , this reference design test bed had an average acceleration of 2.4G's, with a maximum acceleration of 3.34G's and a minimum of 1.65G's.

These values are based on effect 3 (i.e. Sharp tick 100%) playback using Immersion's TouchSense Control Prototyping Module , which is part of the Prototyping and development kit (Immersion p/n CTS-DKIT-SSKV2).

In addition to quantifying measurements, Immersion design team reviews the haptic playback of all desmonstrators and test setups to ensure that the subject feel and strength is acceptable for production.

See Appendix B for summary of measurements.

2.1.8 Next Steps

Electronics and software are necessary to create compelling and immersive tactile touch effects. If you are ready to take this next step, contact your Densitron Sales rep.

Appendix A – Reference Design Details (click on icon next to text)

1. Jinlong 6mm motor data sheet
2. Motor clip detail drawing
3. Sheet metal carrier detail drawing
4. Carrier post detail drawing
5. #2-56 reference specification (Mcmaster Carr part number 90471A115)
6. Sheet metal carrier assembly drawing (including posts, screws, and motor mounting location)
7. 3M 468MP double sided adhesive data sheet
8. Grommet detail drawing
9. Poron 4701-15-06039 urethane foam data sheet
10. Detail drawing of critical dimensions
11. Connection Diagram for Denistron 5.7” touch screen haptic integration
12. Loctite 460 data sheet

Appendix B – Acceleration Measurements

1. Overview
2. Measurement method
3. Measurement locations
4. Measured results

1. <u>Overview</u>

This section outlines how acceleration measurements were acquired and evaluated for Densitron's 5.7" Haptic touch screen.

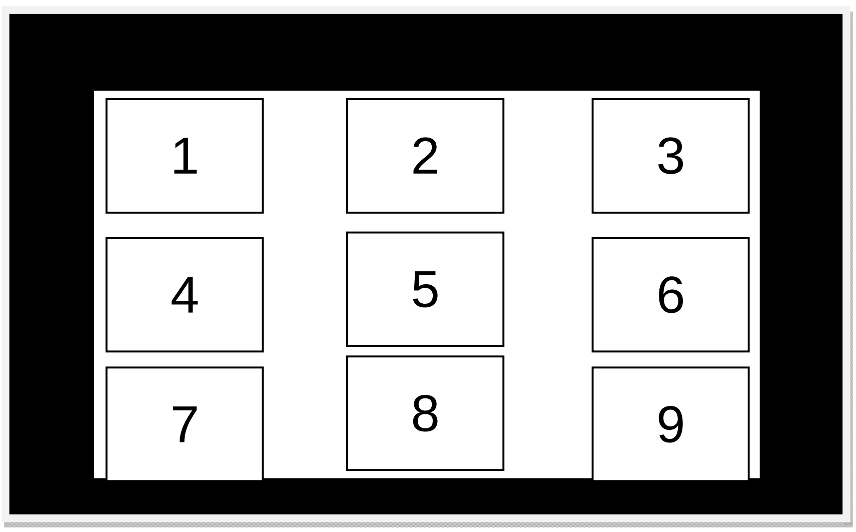
2. <u>Measurement Method</u>

Measurement were taken using Immersion's Haptic Test Kit. This kit includes the neccesary equipment and tools to measure acceleration profiles for a specific location on the touch screen. Acceleration data provides a way to quantify and evaluate the effect playback for a given location on the touch screen. Contact your Immersion Sales for more information regarding this test kit.Measurements are collected using a customer accelerometer and a 3 channel Picoscope (PC Oscilloscope). Immersion's Aries breakout board is used to manually play back effects, which is recorded by the picoscope. The average of a minimum 10 play backs are recorded, and effective acceleration (in G's) is calculated.

3. <u>Measurement Locations</u>

A total of (9) locations on the active touch screen area were measured. The locations are identified below (when looking at the front of the touch surface):

Top



4. Measured Results

Measured results for the final reference design proposal is listed below. Effect 0 was used for haptic playback.

position	x_acceleration (G's)	y_acceleration (G's)	z_acceleration (G's)	vector sum
1	1.04	0.58	2.97	3.20
2	0.47	0.38	1.54	1.66
3	0.47	0.49	1.50	1.65
4	0.82	0.33	3.22	3.34
5	0.51	0.45	1.79	1.91
6	0.52	0.47	1.87	2.00
7	0.60	0.56	2.17	2.32
8	0.69	0.56	2.79	2.93
9	0.75	0.54	2.39	2.57
average	0.65	0.49	2.25	2.40
max	1.04	0.58	3.22	3.34
min	0.47	0.33	1.50	1.65

The vector sum average acceleration is 2.4G's. The vector sum max acceleration is 3.34G'. The vector sum min acceleration is 1.65G's.

In general, the average acceleration is very good. It provides definite feel, and does not over power feel on the finger tip.

The weakest locations were positions 2, 3 and 5. The strength of the effects were about the same in positions 2 and 3.

The strongest locations were positions 1 and 4. This is expected, mainly because the motor is located closest to these positions.

This range in accelerations are common with TS2000 implementations (most haptic implementations range from 1.5-3G's). There are many variables that influence the measurements, including motor mass orientation, temperature, consistency in suspension elements and sealing elements, and assembly quality. At this level of acceleration, most people cannot feel and determine the differences in acceleration.

Also note that these measurements are not always representative of "subjective feel". Aside from the quantitative data, Immersion's Haptic experts evaluate each implementation to ensure that it meets their standard for a quality implementation.

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