

Cho-Form® Robotically Dispensed Form-in-Place EMI Gasketing

Chomerics' Cho-Form Automated EMI Gasketing System

was developed to meet the growing demand for high-speed, high volume application of conductive elastomer seals to metal or plastic housings. It is ideal for cellular handsets, PC cards, compartmentalized enclosures and other tightly packaged commercial electronic devices.

Cho-Form technology allows dispensing of precisely positioned, conformable gaskets in very small cross sections that free valuable package space. The durable, highly conductive seals have low compression set, ensuring years of effective EMI shielding and mechanical performance.

With gasket dispensing primarily software driven, Cho-Form technology permits rapid prototyping, changes in design, and production scale-up at nominal cost. Its inherent flexibility accommodates batch runs or continuous production, from ten to ten million parts.

Wide acceptance of the Cho-Form automated gasket dispensing system can be attributed to a successful blend of manufacturing and materials expertise. Among its important design and performance benefits are:

- up to 60% space saved — flanges as narrow as 0.020 inch (0.50 mm) can be gasketed
- more than 75 dB shielding effectiveness from 200 MHz to 10 GHz with very small gasket beads
- accuracy for gasket location within 0.001 inch (0.025 mm)
- more than 12 Newtons/cm² shear adhesion to common housing substrates and coatings
- highly compressible gaskets, ideal with limited deflection force
- speed — gasketed parts typically prototyped and shipped within several days



Outstanding Production Efficiencies

Cho-Form technology dispenses EMI gasketing at ever-increasing rates in line with our commitment to reduce costs. Our continuous improvement program has enabled us to increase the dispense rate eight-fold in three years, and we pursue additional improvements. The commitment to reducing costs extends to all aspects of the dispensing operation, with the goal of offering superior quality at constantly lower prices.

Excellent Shielding Effectiveness, Even in Small Cross Sections

Shielding effectiveness of Cho-Form gaskets exceeds 85 dB between 200 MHz and 10 GHz. Shielding performance increases with cross sectional dimensions. Results shown for various Cho-Form materials were obtained using very small gaskets, 0.034 inch high by 0.040 inch wide (0.86 mm high by 1.0 mm wide)

Denser Packaging is Possible

Cho-Form gaskets can be applied to walls or flanges as narrow as 0.020 inch (0.50 mm), and don't require mechanical retention. Compared with groove and friction-fit designs, the positional accuracy and self-adhesive properties of Cho-Form



gaskets will typically save 60% or more space. This frees additional board space, or allows for smaller overall package dimensions.

Small Cross Sections, Complex Geometries

Virtually any gasket bead path can be programmed using Cho-Form application technology. In addition to simple straight lengths, the system applies continuous 360° perimeter gaskets in combination with any required number of internal sub-paths that form "T" joints with the perimeter seal. The system produces reliable junctions between bead paths that provide continuous EMI shielding and environmental sealing.

Low Closure Force Not a Problem

Cho-Form gasket materials are ideal for low deflection force designs, or those whose mating surfaces have low mechanical rigidity. Deflection below 10% or above 50% is not recommended. Nominal deflection of 30% and a mechanical compression stop are recommended. An example of typical compression-deflection data for Cho-Form materials appears in Figure 1.

Our exclusive, patented Wave-Form™ bead configuration can reduce closure force requirements of the base material by 20 to 40%. Refer to page 4 for more information.

Secure Gasket Adhesion

Cho-Form gaskets exhibit >8-12 N/cm² of shear adhesion to a variety of common housing substrates, including

- cast aluminum, magnesium or zinc alloys with various platings*
- nickel-copper plating on plastics
- stainless steel (300 series)
- CHO-SHIELD® 2052, 2054, 2056 or 610 conductive coatings
- vacuum metallized aluminum

* CrO₄, black chrome, black nickel, bright nickel, tin

Gasket Application Fully Programmable in 3 Axes

Full 3-axis motion of the Cho-Form application technology accommodates uneven surfaces (with a maximum slope of 80°) common in castings or injection-molded parts. The result is enhanced control of the gasket cross section.

Tight Dimensional Control and "Tail-less" Terminations

Cho-Form gasket beads are dispensed with an accuracy of 0.001 inch (0.025 mm), and a cross-sectional height tolerance of 0.004 inch (0.10 mm).

This innovative, proprietary technology produces clean bead ends without the "tail" characteristic of other processes. The key is precise management

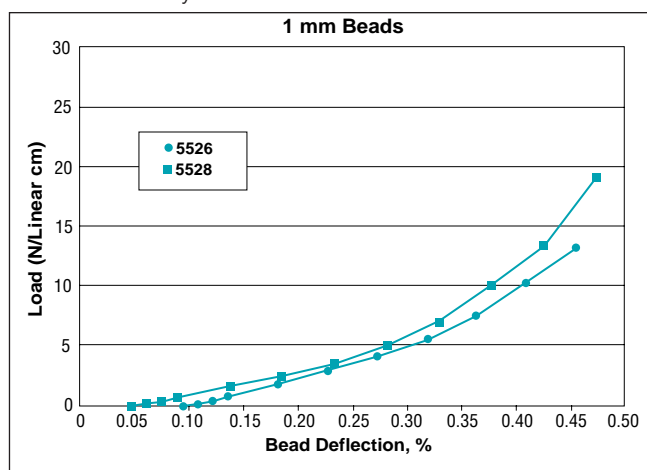
of the flow rate of material through the nozzle, material viscosity and dispensing speed.

Note: Gasket cross section and tolerances will vary slightly at the site of "start" or "stop" events in the dispense cycle (see page 23).



Gasket application to sloped surfaces is fully programmable

Figure 1 Compression-Deflection Example of Moisture Cure Systems



continued



High Levels of Quality Control

Chomerics performs automated dimensional verification of gasket bead placement and height for statistical process control, using fully programmable optical coordinate measuring technology and vision systems. Electrical resistance of cured gasket material is tested with a multimeter capable of measuring to 0.001 ohm. Typical C_p and C_{pk} values are approximately 1.5.



A Choice of Materials Formulated for Automated Dispensing

Cho-Form materials establish >8-12 N/cm² adhesion to many substrates, including magnesium and aluminum alloys and commonly used conductive films such as Ni/Cu plating, vacuum metallized coatings and conductive paints. Producing durable, conformable gaskets, all materials can be applied as beads with cross sections as small as 0.020 inch high and 0.026 inch wide (0.5 mm high and 0.66 mm wide). If design space permits, we recommend using a bead 0.034 inch high and 0.039 inch wide (0.85 mm high and 1.0 mm wide), delivering C_{pk} values >1.33. Bead location accuracy within 0.001 inch (0.025 mm) is possible.

Cho-Form 5513* — Two-component, thermal cure silicone system. Requires a minimum cure temperature of 130°C (266°F). Ag/Cu particle filler makes it the best performing gasket for metallic housings such as aluminum or magnesium castings. Excellent adhesion to a wide variety of substrates, including plated metal film on plastic and conductive paints.

Cho-Form 5518* — Two-component, thermal cure silicone system with Ag/Cu particle filler. Minimum cure temperature is only 85°C (185°F). Formulated for painted, plated or metallized plastic housings that will not withstand higher temperature bake. Also provides excellent adhesion to metallic housings.

Cho-Form 5515* — One-component, thermal cure silicone system, with Ni/Graphite filler. Minimum cure temperature is 100°C (212°F). A low-cost solution for EMI shielding, it is specially formulated to reduce galvanic activity between the housing and EMI gasket, and for use on outdoor applications requiring long-term corrosion resistance.

Cho-Form 5526 — One-part, room-temperature or moisture cure silicone resin with pure silver filler. Provides the lowest possible surface contact electrical resistance with excellent adhesion, compressibility and compression recovery. The ideal choice for higher performance grounding applications or use on semi-conductive surfaces. Suitable for both metallic alloy and plastic housings.

Cho-Form 5528* — One-part, room-temperature or moisture cure silicone resin with Ag/Cu filler. Provides ultra-soft, low closure force gaskets with excellent electrical, mechanical and shielding properties. Compression recovery is comparable to thermal cure systems. Packaging of completed units in 30 minutes can be achieved with accelerated curing at 149°F (65°C) and 85% relative humidity.

*Note concerning material numbers:

Cho-Form 5513 formerly identified as Cho-Form 2.1
Cho-Form 5518 formerly identified as Cho-Form 3.0
Cho-Form 5515 formerly identified as Cho-Form 4.0
Cho-Form 5528 formerly identified as Cho-Form 5.0

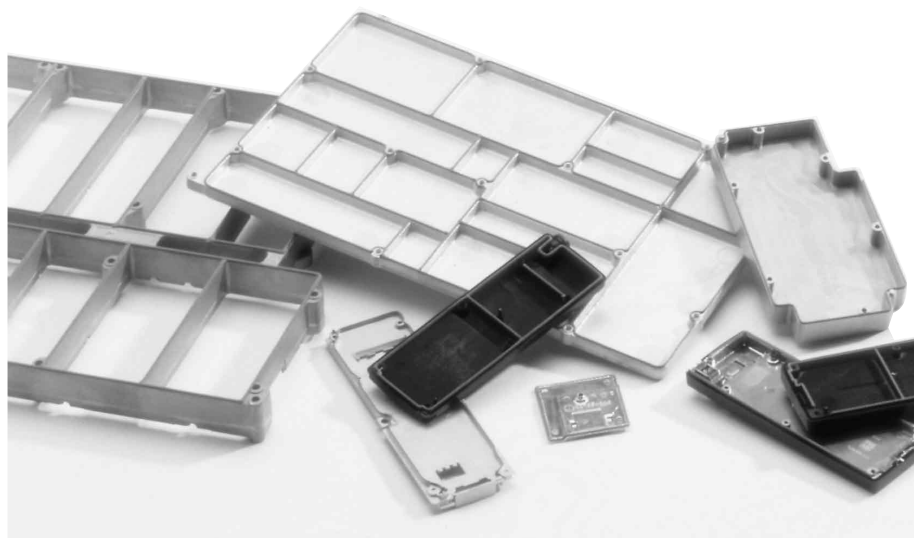


Table 1

TYPICAL PROPERTIES OF CHO-FORM MATERIALS						
Property	Test Method	5513	5518	5515	5526	5528
Base Resin		Silicone (2-part)	Silicone (2-part)	Silicone (1-part)	Silicone (1-part)	Silicone (1-part)
Conductive Filler		Ag/Cu	Ag/Cu	Ni/Graphite	Ag	Ag/Cu
Solvent Level, Wet, %		None	None	None	5-8	None
Cure Mechanism		Heat	Heat	Heat	Moisture	Moisture
Cure Schedule		30 min @ 140°C	30 min @ 85°C 20 min @ 100°C	30 min @ 140°C	72 hrs @ 21°C & 10% RH 24 hrs @ 21°C & 50% RH	72 hrs @ 21°C & 10% RH 24 hrs @ 21°C & 50% RH
Handle Time (min. time to obtain cure sufficient for incidental contact without causing permanent gasket deformation)		NA	NA	NA	20 min @ 65°C & 85% RH 40 min @ 40°C & 50% RH 55 min @ 30°C & 50% RH	20 min @ 65°C & 85% RH 40 min @ 40°C & 50% RH 55 min @ 30°C & 50% RH
Shielding Effectiveness 200 MHz to 10 GHz, 0.034 x 0.040 inch bead (0.86 x 1.02 mm)	MIL-G-83528 Para. 4.6.12, modified specimen 0.85 mm x 1.0 mm bead with plastic bolts	80-100 dB	80-100 dB	75-85 dB	>100 dB	80-100 dB
Volume Resistivity (Initial), ohm-cm, max.	MIL-G-83528 Para. 4.6.11	0.010	0.010	0.200	0.005	0.020
Volume Resistivity (Aged), ohm-cm, max.	MIL-G-83528 Para. 4.6.15	0.020	0.050	0.300	0.010	0.030
Compression Set, 22 hrs. at 85°C (185°F), percent, max.	ASTM D395 Method B ²	25	35	25	35	35
Tensile Strength, psi (MPa), min.	ASTM D412	250 (1.72)	350 (2.41)	450 (3.10)	80 (0.55)	80 (0.55)
Elongation, percent, min.	ASTM D412	250	225	100	45	45
Specific Gravity, typical	ASTM D792	3.4	3.3	1.8	3.3	2.7
Hardness (Shore A), +15, -10	ASTM D2240	45	45	60	40	35
Typical Adhesion ¹ , N/cm ²	WI 038 ²	>8	>8	>8	>12	>12
Use Temperature, °C		85°	85°	100°	85°	85°

¹Adhesion value dependant on substrate²Copy available from Chomerics

NA Not Applicable

Chomerics' exclusive Wave-Form™ dispensing...

**... maximum
shielding with
up to 40%
reduction in
closure force**



At no additional cost, our exclusive, patent-pending Wave-Form bead configuration can reduce closure force requirements of the base material by 20 to 40%. Any listed Cho-Form material can be used. Proprietary motion programming produces a dispensed bead with a wave-like pattern.

A key performance benefit of the Wave-Form technology is its negligible impact on shielding effectiveness of the gasket. Moreover, choosing Wave-Form dispensing does not affect production throughput rates.

In a typical comparison, a conventionally dispensed Cho-Form gasket bead requires 4 N/cm of closure force, while the same material dispensed as a Wave-Form bead requires only 2.6 N/cm.

Contact Chomerics' Applications Engineering to evaluate the suitability of Wave-Form dispensing in your application.

continued

Optimizing the design of Cho-Form Shielded Housing Assemblies

Important Considerations for Optimizing Quality & Production Efficiency

A shielded housing is an assembly whose quality and performance are functions of all the parts and processes used to produce it.

Whenever possible, Chomerics interfaces on behalf of OEM customers with suppliers of die-cast metal and injection-molded plastic housings in advance of tool design and production. Detailed guidance is provided on part and tool design, part reproducibility, locating features, tolerances and surface conditions — issues that are key to the quality and economics of robotic gasket dispensing.

As discussed on page 6, Chomerics can act as lead vendor, managing the entire housing supply chain to ensure the best results for OEM customers.

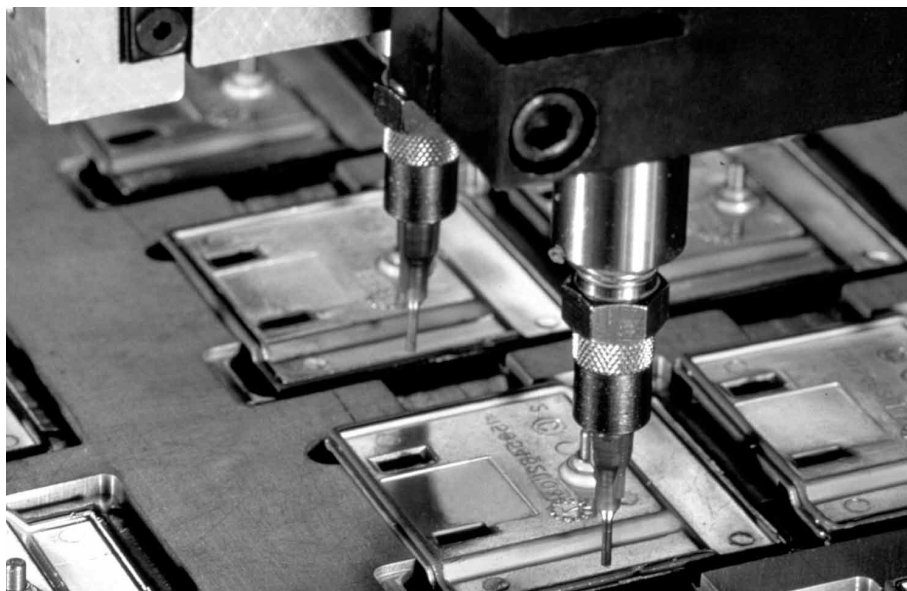
The following section provides answers to commonly asked questions, and highlights critical design issues that affect production efficiency and cost.

Housing Material Considerations

Plastic Substrate Selection

If the housing is an injection-molded thermoplastic, the gasket cure temperature is an important parameter. Different thermoplastics soften or stress-relieve at different temperatures.

Polycarbonate/ABS blends offer significant process advantages for Cho-Form gasket application. While somewhat more expensive than other plastics, virtually all PC/ABS blends will withstand 85°C (185°F), and therefore allow efficient gasket “quick cure” in-line. In contrast, plastics that require room temperature gasket curing necessitate batch processing, with attendant cost and logistic (time) disadvantages.



For maximum production throughput, Chomerics generally recommends that plastic housings be able to withstand curing at 85°C for up to 40 minutes without deforming.

Surface Preparation

Metal or plastic surfaces to be gasketed with Cho-Form materials should exhibit electrical resistance of <0.01 ohm. They should be clean and free of dirt, oils and organic solvents.

Metallic housings must be treated to remove release agents and machining oils. Aluminum parts should be chromate conversion coated (alodine or irridite) per MIL-C-5541 Class 3. Magnesium parts should be protected with Dow 20 modified chrome pickle or equivalent.

Plastic housings require metallizing, which may be accomplished by plating, aluminum vacuum deposition or conductive paint.

For plating, nickel-copper is preferred. It adheres well, provides 80+ dB of shielding effectiveness, and remains electrically stable over time.

If vacuum deposition is chosen, a nitrogen purge is mandatory to ensure good adhesion.

Differences in commercially available conductive paints necessitates testing them with the selected Cho-Form gasketing material. Chomerics' CHO-SHIELD® 2052, 2054, 2056 and 610 conductive coatings have been formulated to adhere well and be galvanically compatible with Cho-Form materials. The superior performance and batch-to-batch uniformity of these silver-copper-filled paints have been extensively demonstrated in these applications. Their high abrasion resistance provides protection during product assembly and use.

Chomerics applies CHO-SHIELD coatings robotically in-line, as an integrated part of the automated Cho-Form application process. This capability provides significant logistical, time and cost benefits.

Protective Packaging

To avoid cosmetic injuries such as surface scratches, parts should be shipped in compartmentalized plastic or corrugated paper trays. If requested, Chomerics will arrange for specialized packaging to be delivered to the housing manufacturer.

Optimizing the design of Cho-Form Shielded Housing Assemblies

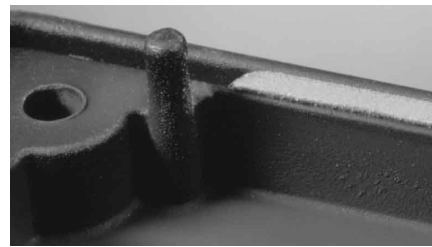
Gasket Design Considerations

Start/Stop Bead Profiles

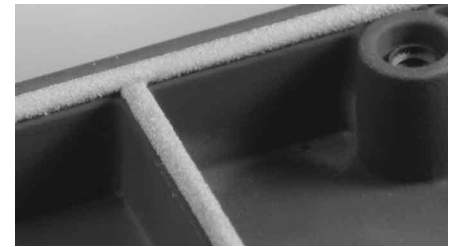
Designers should anticipate slight differences in gasket bead cross section in the start/stop zones compared with the very uniform profile produced during steady-state dispensing of straight runs. Figures 2-5 illustrate the nature of these intrinsic differences and the adjusted tolerances in the initiation and termination zones, which are defined as 0.100 inch (2.54 mm) long.

Engineering drawings should reflect a less well-defined gasket profile in start/stop zones, to facilitate Quality Control inspections of incoming parts. Suggested drawing references appear in Figures 3 and 4.

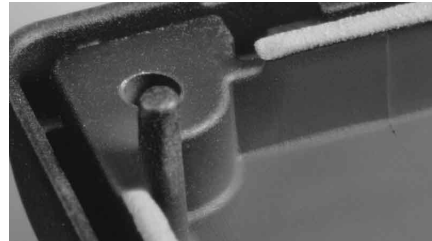
In programming the dispense path, sufficient flexibility exists to minimize the number of start/stop events and to locate such events where the gasket profile is not critical. Part drawings should identify any areas in which the increased cross section tolerances associated with start/stop zones would create a problem.



starting event



"T" stop



full circle perimeter stop



straight run stop

Figure 2 Characteristic appearance of start/stop events

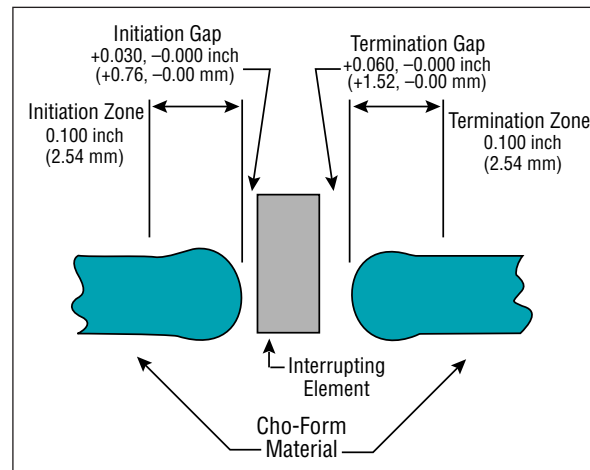
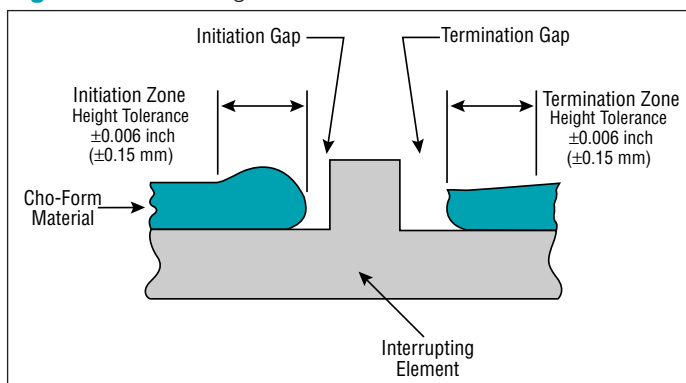


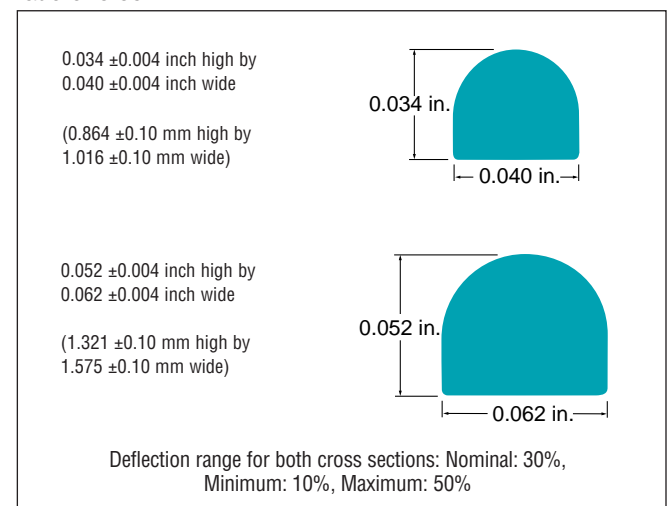
Figure 3 Location tolerances for bead initiation & termination zones (cross-sectional view)

Figure 4 Gasket height tolerances



Cho-Form gasket beads are dispensed with an accuracy of 0.001 inch (0.025 mm) and a straight-run height tolerance of ± 0.004 inch (± 0.10 mm). The exception is within 0.100 inch (2.54 mm) at the start and end of a bead (initiation zone and termination zone respectively), where ± 0.006 inch (± 0.15 mm) is the height tolerance.

Figure 5 Suggested cross sections with height-to-width ratio of 0.85



continued

Critical Housing Design Issues

Cho-Form FIP gasket technology accommodates a reasonable degree of variability in housing part dimensions. However, setup and dispensing speed are directly impacted by part uniformity. In addition, the housing design can pose obstacles to efficient gasket dispensing.

The most common avoidable problem is warped or non-uniform housings. If housings are not sufficiently flat and dimensionally uniform, they must be restrained by special alignment and hold-down fixtures, which can add substantial setup time.

For best results and production economics, designs should reflect the following considerations:

Positive Locating Features Speed Production

Parts should be easily fixtured for fast, accurate dispensing

Reproducible positioning of the parts beneath the dispensing head is fundamental to this automated technology. Maximum production speed can be achieved when through-holes are available to pin-position parts on the pallets that transport them to the dispensing head. If through-holes are not available, two sides can be pushed against pallet rails for positioning. This requires hold-down clamps that must be positioned without interfering with the dispensing needle.

Avoid features that complicate design of a locating system

Parting lines in dies or molds can interfere with the establishment of a locating edge. Mold gates, runners or flash can interfere with positioning pins or fixtures.

Part Reproducibility is Critical

Flanges, rails or ribs to be gasketed should have part-to-part location reproducibility (X and Y dimensions) within 0.008 inch (0.20 mm)

Once the dispense path is programmed, all surfaces to be gasketed must be located where the program assumes them to be. Variation greater than 0.008 inch (0.203 mm) will result



in gasket beads dispensed partly on and partly off the intended surfaces.

Housings must be reproducible in the Z axis within 0.012 inch (0.30 mm)

Manufacturing processes for die-cast metal and injection molded plastic housings generally can produce parts with intrinsically reproducible, uniform dimensions in the Z axis.

Several factors determine the gasket bead profile — air pressure in the needle, material viscosity, needle diameter, feed rate and needle height (Z) above the part. Accurate Z-axis programming is central to dispensing an optimum gasket profile. Full 3-axis programmability of the Cho-Form dispensing heads is an important advantage in accommodating the necessary tolerances on the Z-axis position of the surface to be gasketed.

Selection of a housing supplier able to meet the reproducibility requirements for the Z-axis can make a real difference in the quality, speed and economics of gasket dispensing.

Production housing functions as master

The Cho-Form gasket dispensing head is programmed in 3 axes by plotting the path which the needle will follow, using a representative production housing as the master. Programming can account for unintended but consistent deviations in elevation, such as:

- non-parallelism
- non-flatness
- warping

In aggregate, these elevation deviations must be consistent from part to

part within 0.012 inch (0.30 mm). If not, special mechanical restraint fixturing will probably be required to ensure accurate gasket dispensing. Fixturing schemes usually entail delay and expense and may also impact production speed.

Parallelism to a defined plane

Using one or more specific part features for locating purposes, housings are mounted on a machined pallet and conveyed to the dispensing head. The pallet surface defines the “datum plane” for Z-axis motion of the dispensing needle.

A Cho-Form gasket can be dispensed onto a part surface of known slope with respect to the datum plane (up to 80°). Application onto a flat surface (i.e., 0° slope) can actually be more difficult than application to a sloped surface if part thickness is not consistent. Variation in overall part thickness will cause the surface to be gasketed to be non-parallel with the datum plane. Z-axis adjustments to the needle's path are programmed using the representative “master” part. However, these variations must be consistent in both location and degree, and within the 0.012 inch (0.30 mm) aggregate allowable tolerance to avoid the need for special fixturing. (Figures 6 a-b.)

Flatness of the surface to be gasketed

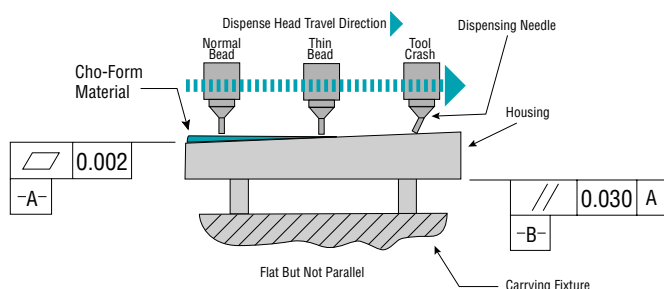
Unevenness in flanges, rails or ribs to be gasketed can be programmed into the Z-axis motion of the dispensing head. Again, this Z-axis variation must be consistent from part-to-part within the 0.012 inch (0.30 mm) aggregate tolerance to avoid the need for fixturing. (Figures 7a-b.)

Warping of the housing

As with parallelism and flatness of the surface to be gasketed, warping of the entire part can contribute to a Z-axis variation that exceeds the 0.012 inch (0.30 mm) tolerance for reproducibility. The trend toward smaller electronic packages with thin housing walls makes this a common occurrence. If surfaces for part hold-down are available, this condition can be accommodated by fixturing. However, setup and production time will be affected.

Optimizing the design of Cho-Form Shielded Housing Assemblies

6a Non-reproducible non-parallelism >0.012 inch (0.30 mm) results in uneven bead



6b Program adjusted for reproducible non-parallelism >0.012 inch (0.30 mm) results in uniform bead

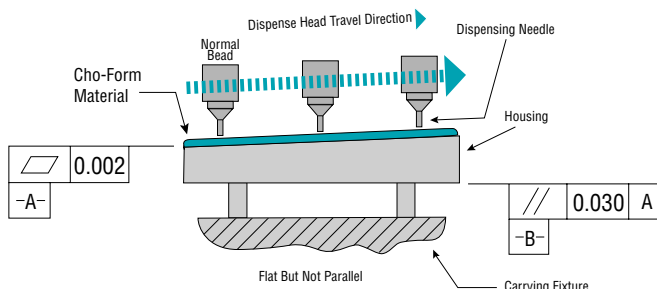
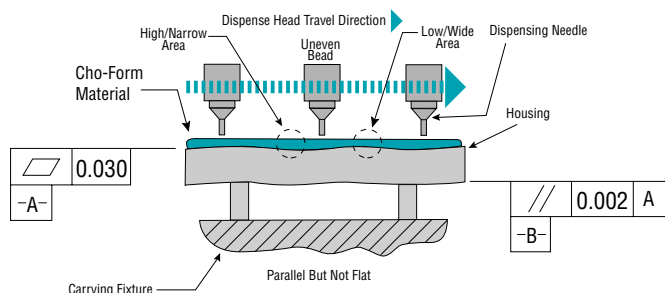


Figure 6 Non-parallelism between receiving surface and pallet surface

7a Non-reproducible non-flatness >0.012 inch (0.30 mm) results in uneven bead



7b Program adjusted for reproducible non-flatness >0.012 inch (0.30 mm) results in uniform bead

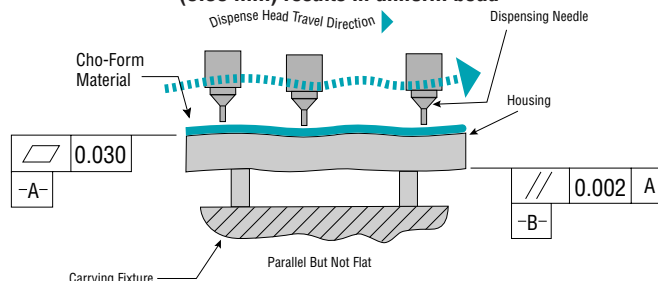


Figure 7 Non-flatness of gasketed surface

Keep the need for part restraint to a minimum

When the part-to-part reproducibility requirement cannot be met, mechanical restraints are fabricated which temporarily flatten the part for proper dispensing of the gasket. Whenever possible, Chomerics exploits design features such as through-holes and edge rails for clamping. If such features do not exist, more complicated fixturing schemes must be designed to induce the necessary flatness, with a corresponding time and cost penalty.

Avoid Z-axis Obstructions

Sidewall proximity to the dispensing needle

Often, a form-in-place EMI gasket is applied along a "ledge" adjacent to a higher sidewall. The dimensional tolerances on ledge and sidewall locations are particularly critical, to avoid sidewall interference with the moving needle (Figure 8).

Side pressure on the needle produces a change in gasket profile. However, because the Cho-Form dispensing head positions the needle with 0.001

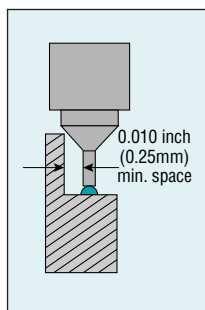


Figure 8 Sidewall interference with dispensing needle

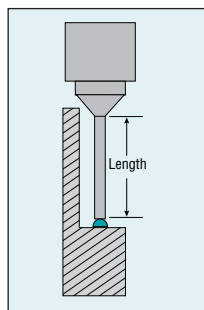


Figure 9 High sidewalls may necessitate longer needles, reducing speed

inch (0.025 mm) accuracy, this should not be a concern provided that part-to-part dimensional consistency is within 0.010 inch (0.25 mm).

High sidewalls slow dispensing

High sidewalls adjacent to the gasket dispensing path may require an elongated needle to provide the necessary clearance for the dispensing head (Figure 9). The longer needle adds friction to material flow, reducing dispensing speed by as much as 75%. This can frequently be avoided by position-

ing high sidewalls on the mating part or by reducing their height.

Through-hole interference

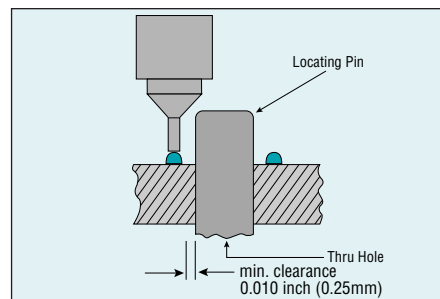


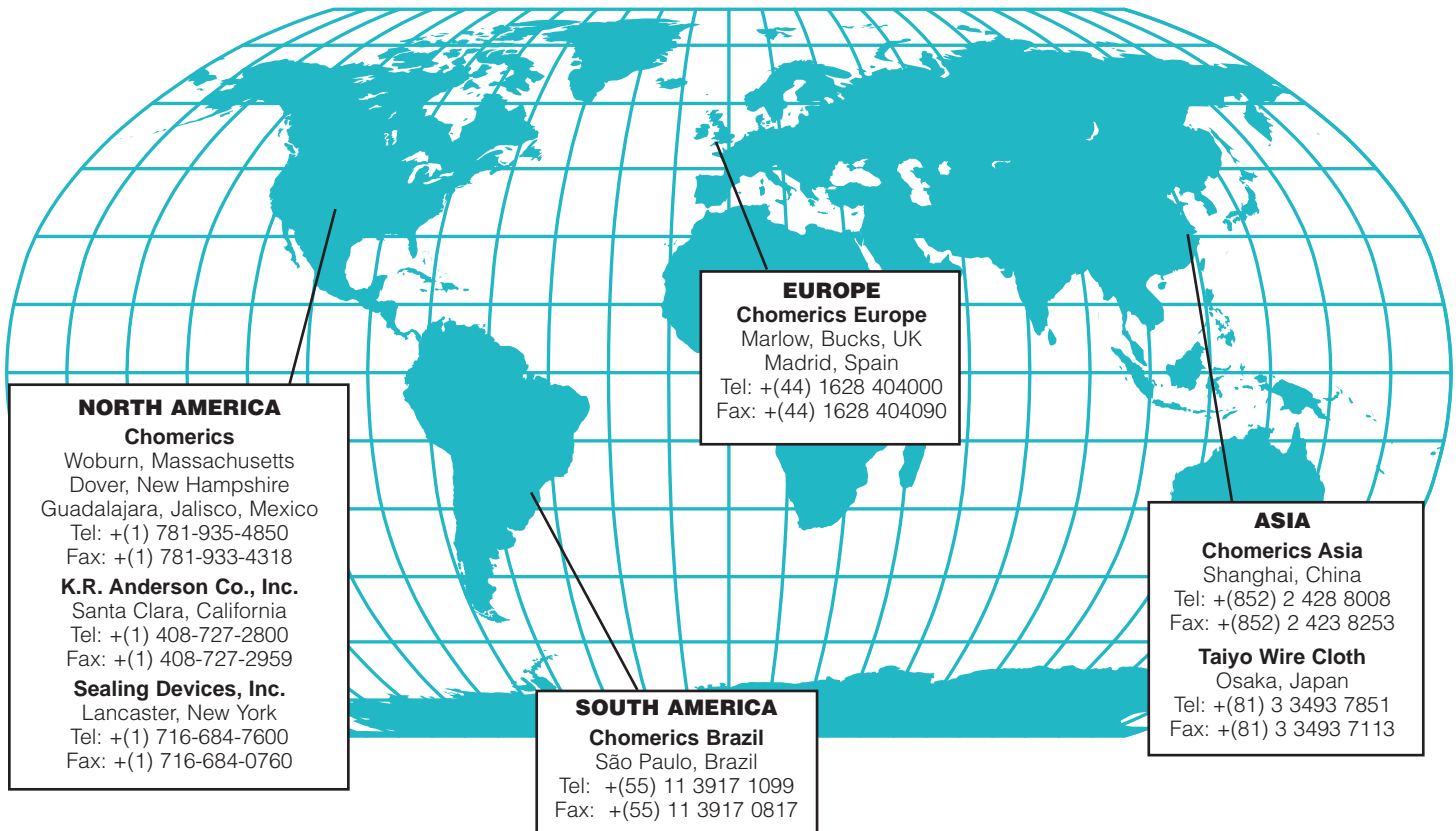
Figure 10 Dispensing path obstructed

In cases where the housing incorporates through-holes used to position the part on its pallet, the holes must not intersect the dispensing path. Clearance of less than 0.010 inch (0.25 mm) could result in screw heads or locating pins obstructing the dispensing needle (Figure 10).

continued

Global Access to Application Sites

A growing network of Cho-Form Application Sites offer automated EMI gasketing, part painting and contract manufacturing services, sometimes at close proximity to customers' own or subcontractor locations:



Mapping New Sites to Your Operations

Where production volumes warrant, Chomerics is pleased to explore the establishment of EMI gasket dispensing and part painting operations at our customers' locations. Advantages of such an arrangement include:

- meeting in-country content stipulations
- simplified logistics
- local sales support, quality support and customer service

To evaluate the feasibility of establishing Chomerics applications sites at or near your company's operations, contact the Cho-Form Business Unit at our Woburn, Massachusetts headquarters.