CHOMERICS Parker

PREMIER™

High-Performance Conductive Thermoplastics for EMI Shielding

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Conductive Thermoplastics for EMI Shielding

Electrically Conductive EMI Shielding Thermoplastics

PREMIER™ is the world's first commercially available conductive thermoplastic for real world EMI shielding solutions. It is a blend of PC/ABS thermoplastic polymer alloys and conductive fillers engineered for stable electrical, mechanical, and physical performance. The conductive filler technology utilizes nickel plated carbon (Ni-C) fibers as the base filler. In the case of higher shielding versions, Nickel-Graphite (Ni-C) powder is blended with the fiber base to deliver enhanced performance. Combined with standard injection molding processes, PREMIER technology delivers evenly dispersed filler throughout a part's geometry (Figure 1). PREMIER parts have no resin rich areas prone to EMI leaks, and no brittle, resin poor areas that can break under mechanical stress. PREMIER provides world class shielding effectiveness, requires no machining, plating, painting, vacuum coating, or other added processing steps. The elimination of secondary operations can reduce costs by up to 50% compared to die castings, bent formed metal, machined extrusions and plated plastic parts.

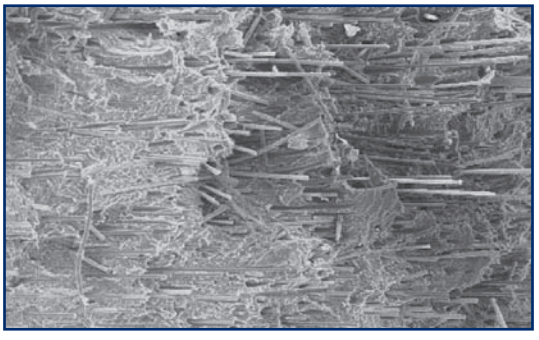
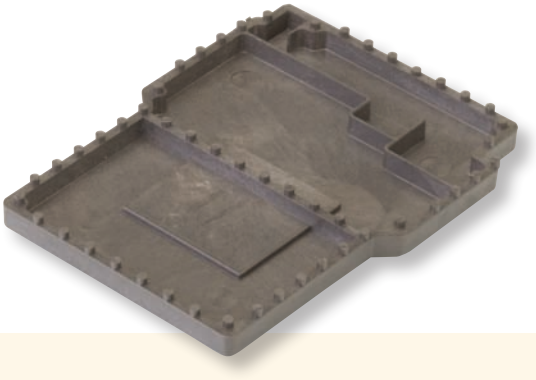


Figure 1: Broken edge of PREMIER showing fiber powder distribution (70X magnification)



Features/Benefits

SHIELDING
- Greater than 85 dB shielding effectiveness
- Low through resistance down to 30 m Ω
- Highly conductive
- High permeability (6.5) increases shielding effectiveness

MECHANICAL / PHYSICAL
- High tensile strength and modulus
- High flexural strength and modulus
- Low density provides weight reduction up to 75%
- UL 94 flammability rating of V-0

ENVIRONMENTAL
- Recyclable – conforms to WEEE EoVL TCO
- Compliance – RoHS, Halogen-free, EPA
- Up to 105˚C Relative Temperature Index (RTI)
- Corrosion-free for long field life

ECONOMICS
- Lower total cost of ownership through elimination of secondary operations
- Six sigma processing
- Waste elimination
- Global supply available for rapid delivery

Shielding Breakthrough: PREMIER's Unique Filler Technology

PREMIER™ EMI shielding performance is based upon proprietary filler technology which optimizes materials, dispersion and morphology.

The filler matrix within PREMIER starts with a nickel plated carbon (Ni-C) fiber. Electrolytic plating with nickel establishes excellent adhesion to the flexible carbon core, preventing stripping off of the nickel during the injection molding process. Enhanced shielding performance and part fill is achieved by the addition of nickel plated graphite powder. By optimizing particle shape, size distribution and particle-to-fiber ratio, up to 85 dB of shielding effectiveness is obtained. The powder is integrated into the fiber matrix securing more points of electrical contact both on the part surface and inter-fiber. PREMIER's uniquely engineered filler system delivers 6 sigma molding performance at various cost-performance break points. Unlike stainless steel fiber fillers, the carbon core will bend and flow around and into cavity details without breaking or clogging. The inherent material properties of both nickel and carbon make PREMIER a highly lossy (dissipates energy) material that is paramagnetic.

To ensure even dispersion, the Ni-C fibers are treated with a unique, proprietary dispersion technology. The dispersion agent when combined with the low sheer mechanical action experienced in the injection molding process delivers a randomly oriented, evenly dispersed and interlocked fiber matrix within the polymer. Only Chomerics has a dispersion agent that effectively promotes an even matrix throughout complex part geometry. Only PREMIER eliminates the gate clogging typically found with EMI shielding plastics.

When dispersed the engineered fiber matrix provides the optimum filler morphology for performance. The foundation of PREMIER's EMI shielding performance is the high aspect ratio Ni-C fiber. The long pathways of uninterrupted electrical conductivity provide low bulk conductivity. A minimum level of fiber is needed to provide effective EMI shielding and all grades of PREMIER have this level. To increase perfomance, particulate nickel graphite powder is added to the base fiber matrix to create higher shielding grades. The inclusion of powder to augment the fiber matrix is indicated by "HF" in the material grade designation (Figure 2).

PREMIER is a single component pellet system. The polymer is cross head extruded on top of the dispersion agent treated Ni-C fiber tow. The "HF" grade has nickel graphite powder that is compounded into the polymer. The polymer-filler system is chopped into pellets ready for injection molding. The pellet length optimizes the conductive fiber aspect ratio to maximize shielding. The single component system eliminates mixing or weighing at the press, fiber nesting and clogged extruder throats.

PREMIER parts provide shielding effectiveness greater than 85 dB to meet global commercial EMC requirements. PREMIER provides the electrical conductivity, EMI absorption, and mechanical durability to replace aluminum and plastic housings that have been metallized or conductively coated. The shielding effectiveness of PREMIER is far greater than that of carbon-filled ESD (electrostatic discharge) plastics.

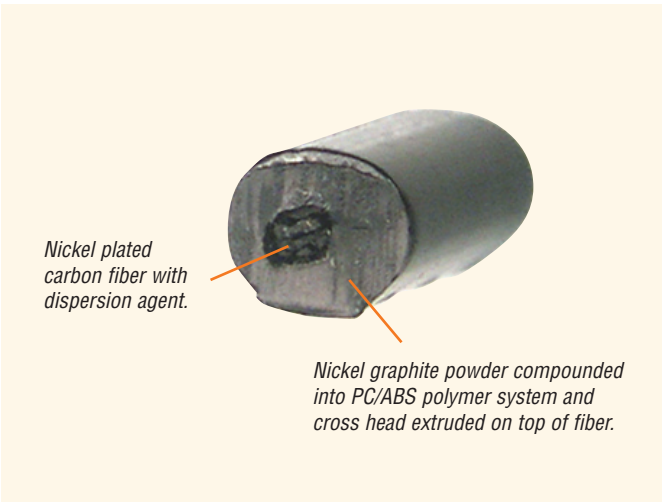


Figure 2: Polymer construction "HF" material grade designation

PREMIER™ Provides Maximum Performance at Lower Costs

PREMIER can reduce costs by up to 65% and provide a lower total cost of ownership with a shorter time to market.

PREMIER EMI shielding thermoplastics eliminate most secondary operations to save money and time (Figure 3). Supply chains can be reduced to as little as one step — injection molding.

Unlike metal die castings there is no need for machining to obtain needed dimensional tolerances or flatness. Plating to control corrosion and sporadic yield losses due to porosity (often exposed in the pre-plating etching process) are eliminated. Also gone are the inspection costs and uncertainty of problem containment. Shipping costs and time in transit to specialized platers no longer inflates cost, increases work in process (WIP) and prolongs lead time.

Unlike metal parts fabricated from aluminum extrusions, cutting-to-length and machining features such as through-holes are not required with PREMIER. The injection molding process provides all part features with 6 sigma reliability. Often part elements cannot be incorporated into the extrusion cross section and require secondary assembly. An example is PCB mounting bosses on a blade front panel. The freedom to design bosses and other features into an injection molded part reduces assembly needs, costs and yield losses.

Unlike parts injection molded with non-EMI shielding plastic, PREMIER parts do not require the secondary operation of plating or painting for EMI shielding. PREMIER thermoplastic parts that come out of the tool have shielding effectiveness engineered in as a base property. PREMIER eliminates the direct cost of secondary EMI shielding and 4-6% yield losses due to:

- "Overspray" on selectively plated parts
- Delamination of metallized coatings due to contamination or humidity
- Inability to reliably reach part area with line-of-sight coating technologies due to part geometry shading areas
- Solvent-based conductive paints crazing plastic surfaces
- Additional handling and transportation

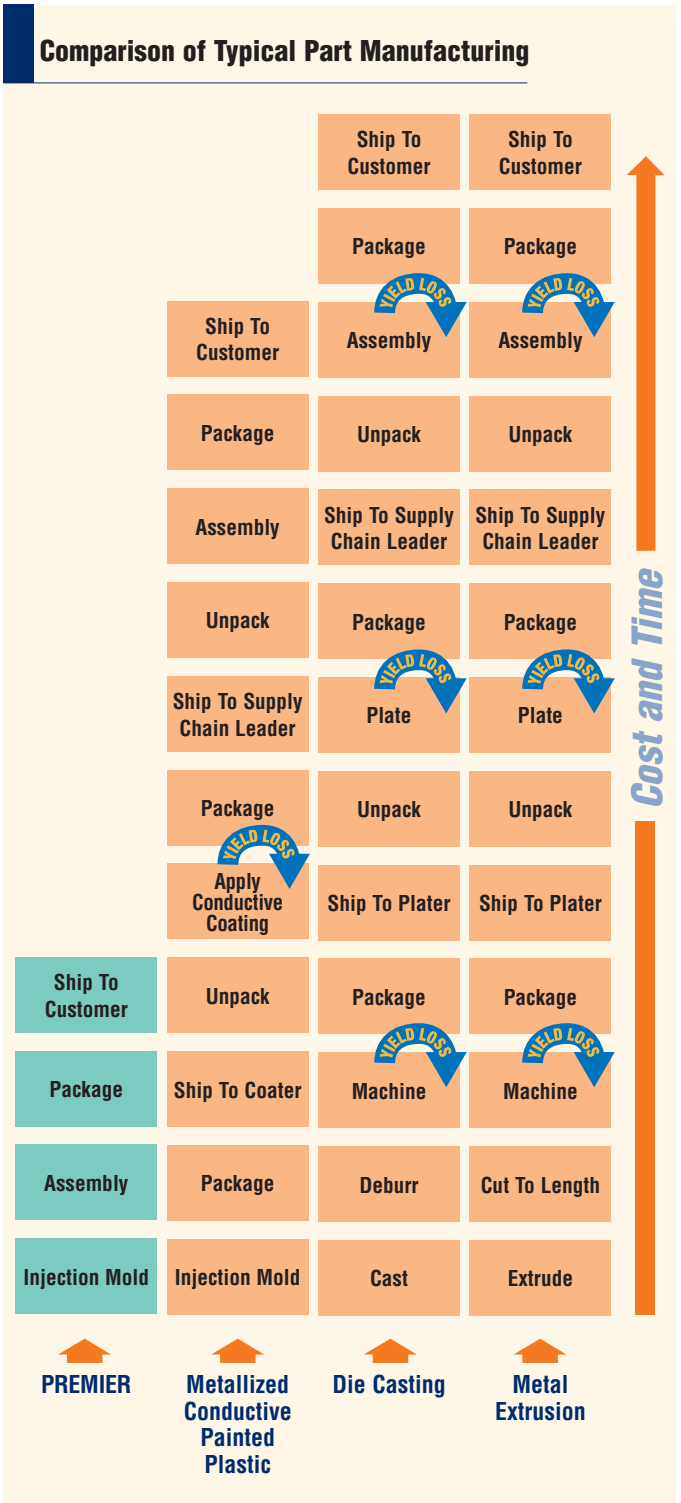


Figure 3: PREMIER thermoplastic reduces complexity and process steps

Costly sorting and rework efforts can be eliminated using PREMIER™. Since standard injection molding equipment and processes are used with PREMIER, quality is built into the process, and not inspected in after manufacture.

PREMIER shortens the supply chain, saving packaging and shipment costs to specialized coaters. The production process is lean and responsive to customer demands.

PREMIER reduces tooling layers, start-up costs and accelerates time to market. PREMIER tooling consists of a thermoplastic injection mold that can be sourced anywhere in the world. There are no masks, hanging racks, machining jigs or unnecessary assembly fixtures. This single tooling layer means fewer processes to develop and approve, saving time and money. Now production part approval can be obtained with one stop.

Since PREMIER is not abrasive to tooling surfaces, the injection molding tool may last up to 1,000,000 shots/cavity. This far outlasts die cast tooling, paint masks, and machining jigs. Tooling replacement and repair needs are a fraction of other processes. Ongoing engineering support on major programs is virtually eliminated, resulting in an uninterrupted supply of parts.

If all features cannot be designed into the injection molding process, any secondary assembly of components onto a PREMIER part can occur right on the injection molding floor. Use of standard ultrasonic or vibration welding, heat staking or mechanical assembly techniques all work with PREMIER. Self-forming screws are commonly used.

By using insert molding or two shot molding, many assembly needs can be engineered into the injection molding cycle. These processes remove the human factor to deliver high reliability with virtually no added processing costs. The need for aluminum heat sinks and areas of non-conductivity are commonly satisfied with these techniques.

PREMIER™ Is Environmentally Friendly

PREMIER complies with worldwide directives for ecological compatibility, such as the European Union Restriction on Hazardous Substances (EU-RoHS), TCO (Swedish Confederation of Professional Employees), and U.S. Environmental Protection Agency standards, by containing no halogenated or banned compounds. PREMIER allows for compliance with Ecma Product-related Environmental Declarations by containing no substances listed as hazardous for plastic components.

If a device's function includes prolonged skin contact, PREMIER material complies with EN1811 for Ni extraction, allowing for use on hand-held devices. The specification, developed by CEN (Comité Européen de Normalisation, European Committee for Standardization) in response to dermatological reaction to nickel plated jewelry, sets a threshold limit of 0.50 µg/cm^2/week of nickel leaching when the item comes in contact with perspiration. PREMIER performance is well under the limit.

At the end of product life, PREMIER parts can be recycled by regrinding using a nibble granulator to comply with stringent disposal regulations. Unlike painting or plating, no costly stripping is required, eliminating end-of-life issues. Scrap as may occur in normal production from runners, startup, shutdown or other sources can be re-ground and re-used eliminating waste during the production cycle. Re-ground PREMIER parts may be used up to 15% by weight without affecting performance. PREMIER allows for cost effective compliance with end-of-vehicle-life (EoVL), TCO and the EU Waste in Electrical and Electronic Equipment (WEEE) directives.

NEBS Compliance

-FR versions of PREMIER comply with stringent flammability needs specified by Network Equipment Building Standards (NEBS). When tested in accordance with Underwriters Laboratory (UL) Standard 94, -FR grades are rated V0 and 5V. They also have oxygen index ratings greater than 28% and pass needle point flame testing. Flame retardant PREMIER (-FR) can be used with confidence in network equipment.

Price and Performance Material Choices

PREMIER™ plastics are provided in three PC/ABS based families: HT, for 85˚C RTI applications, ST, for 105˚C RTI applications, and FR, for 70˚C RTI applications where UL 94 V-0 flammability grade material is required (the flame retardant is non-halogenated). Each PREMIER family offers three standard material grades based on the level of conductive filler. Increasing filler loading increases EMI shielding performance. Multiple levels of fiber loading allow a cost effective match of the desired amount of EMI shielding with the lowest possible material cost. Fill levels are identified as follows: A220 = Low, A230 = Medium, A240 = High. The resin family is specified in the part number by the two letter identifier after the filler loading level number (e.g., A220-FR for low filler level 70˚C flame retardant material). If the resin is available with a blend of fiber and powder, HF is added after the resin identifier; filler blends are not available at the A220 level. See the typical property table (Table 2) for all commonly used grades. PREMIER grades at medium and high filler are also available in all fiber forms. Contact Chomerics for information on these grades.

PREMIER EMI Shielding Solutions

Chomerics can make PREMIER your EMI shielding solution through the supply of molded parts or raw pellets into your supply chain. Chomerics has extensive in-house capabilities to design, prototype, and manufacture PREMIER parts with optimum mechanical and electrical characteristics. As the leading provider of quality shielding solutions, hundreds of millions of Chomerics parts and materials are employed in telecommunications, consumer, military, automotive and industrial electronics around the globe. To verify your product's EMC performance, Chomerics has in-house test services that are globally certified to FCC, EC, VCCI, IEC 1000, EN61000 Series, CISPR, Austel and EU regulations. Chomerics also performs certified product safety testing.

PREMIER and Your Supply Chain

Our unique EMI shielding design experience is a true asset to your supply chain team. We leverage our knowledge in the tool design and molding processes to ensure excellent performance of your design in production. Your parts are optimized for EMI shielding, and mechanical and environmental performance. For customers with limited experience or resources, Chomerics can manage dynamic supply chains. We are a global manufacturer that routinely coordinates multiple vendors, locations, shipping and import/export procedures.

Direct Part Supply from Chomerics

Our customers routinely enjoy significant cost savings and convenience using Chomerics as a single point of contact. PREMIER molded parts can be produced worldwide at Parker locations in the Americas, Asia and Europe.

Bulk PREMIER Pellets

Chomerics works with global injection molders to make the availability of PREMIER conductive plastic shielding solutions as convenient as possible. We support each step of the sales and production process to assure the highest quality parts for your shielding customers.

Bulk PREMIER pellets are provided in the HT, ST, and FR series. Each pellet contains a measured Ni-C fiber bundle treated with Chomerics' dispersion technology set within a polymer jacket. Pellets are ready to use without weighing or dry blending. They can be ordered in a 55 pound (25 kg) box or 1,000 pound (454 kg) Gaylord.

Part numbers for PREMIER pellets are built from WW-A2XX-YYZZ where XX is the filler level descriptor and YY is the family descriptor:

WW	A2XX	YY	ZZ
PREMIER Pellet Unit of Measure	**Filler Level**	**Family Descriptor**	**Filler Blend Descriptor**
CK = Kilograms	A220 = Low	HT = Standard Temperature 85˚C	All Fiber = Blank
CP = Pounds	A230 = Medium	ST = High Temperature 105˚C	Fiber Powder Blend = HF
	A240 = High	FR = Flammability Rated, UL94 V-0	

Chomerics provides start-up assistance on prototyping, tool design and processing. If required, custom PREMIER material blends can be formulated. Contact Chomerics to discuss the full range of PREMIER support services available.

Shielding Effectiveness

PREMIER™ thermoplastic is both electrically conductive and paramagnetic, which provides levels of EMI shielding beyond the indicated performance of surface conductivity tests. A surface conductivity test of a PREMIER part underrepresents its total shielding performance.

The total amount of shielding effectiveness of any EMI shield is equal to the reflective and absorptive losses. The greater the conductivity, permeability, thickness and frequency, the greater the attenuation due to absorption. The greater the conductivity and the lower the frequency, the greater the reflective losses. PREMIER has permeability significantly greater than most commonly used EMI shielding materials as shown in Table 1.

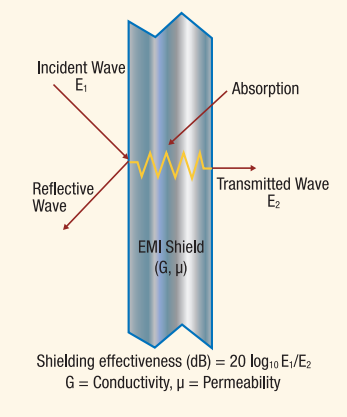


Figure 4: Shielding Effectiveness

Commonly used metals, such as aluminum and magnesium alloys, shield based upon their conductivity with little to no permeability. EMI shielding is achieved primarily by reflection (especially below 10 GHz) and absorption due to skin depths. PREMIER's permeability provides incremental shielding effectiveness above the reflective losses by way of enhanced absorption at all frequencies. The added absorptive shielding outperforms lower reflective losses, thus making PREMIER a viable alternative in such applications.

Table 1 - Shielding Effectiveness Parameters

Material	Surface Resistance (Ω/square)	Permeability (μ)	Typical Shield Thickness (mm)
PREMIER	0.030 to 4.5	6.5	0.8 to 3.0
Acrylic paint Ag/Cu filled	0.05 to 0.10	<<<<1	.0025 to .005
Vacuum Deposited Al	0.01 to 0.20	1	.00025
Nickel over Copper Plating	0.01 to 0.10	≈50	.0001
Aluminum Alloys	.005 to .050	1	1.5 to 3.0

Compared to surface coatings such as vacuum deposited Al, Ni/Cu plating or conductive paints, higher grades of PREMIER can be equal in conductivity, providing comparable reflective losses. All grades of PREMIER provide significantly higher shielding absorption due to the permeability and thickness. PREMIER is used as the structural element with thicknesses at least an order of magnitude greater than the coating. Shielding from absorption is directly proportional to thickness, allowing PREMIER to outperform surface coatings.

PREMIER's nickel, graphite and carbon fiber components all possess intrinsic lossy properties. By using these materials, PREMIER's absorptive properties exceed any other commercially available conductive plastic EMI shielding material. Excellent shielding effectiveness is obtained by adding PREMIER's reflective and absorptive performance together.

Figures 6, 7 and 8 present data on PREMIER performance. The graphs show shielding effectiveness per a far field antenna measurement and ASTM 4935. All data show increased shielding as frequency increases as predicted by the absorptive properties of PREMIER. Each recognized procedure is designed for the frequency range reported and a test report can be supplied on request.

An application's mechanical design is critical to optimizing the shielding performance of any material. An effective EMI shielding scheme features a conductive shielding medium, with 360 degrees peripheral ground and termination of the shield at mating flanges.

For applications that do not use an EMI shielding gasket at the seams, or with large openings, PREMIER™ will perform comparably to metal based designs. The seam or opening will provide less shielding than the housing material, making the seam or opening the determining component of the housing's overall shielding performance. Generally, a non-gasketed seam with good incidental contact will deliver 60 to 70 dB (800 MHz to 12 GHz) shielding effectiveness in both PREMIER and aluminum. Typically, surface plated plastic housings will have 3 to 5 dB less shielding effectiveness than PREMIER. Copper-filled coatings will be 5 to 10 dB less.

To optimize performance, a torturous path joint with a maximized surface area is suggested for seams instead of a simple butt joint. Five to fifteen dB of shielding performance can be added to a typical PREMIER housing using a fabric-over-foam gasket, such as Chomerics' SOFT-SHIELD® 3500, 5000 or 4800 Series, a form-in-place conductive elastomer gasket, such as Chomerics CHO-FORM® family of materials or a hollow/spliced conductive extrusion captured in a groove.

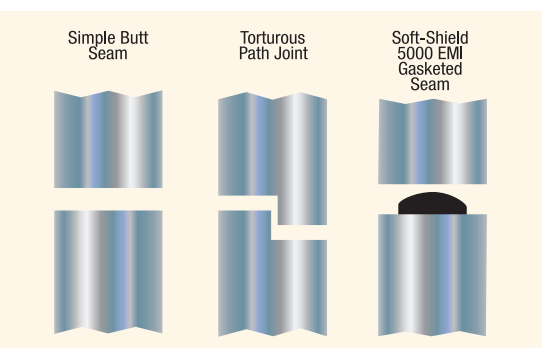
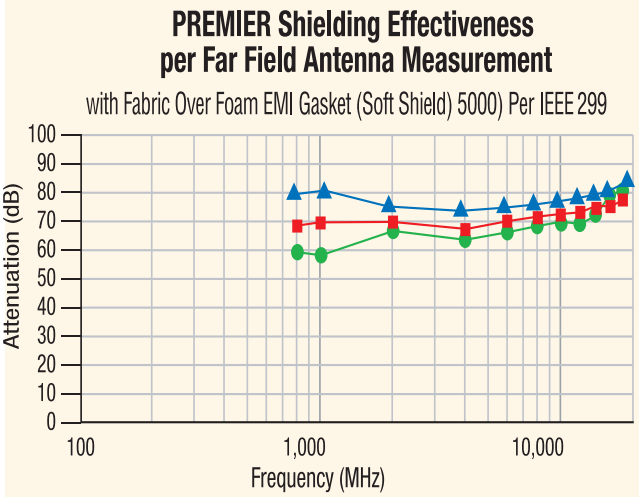
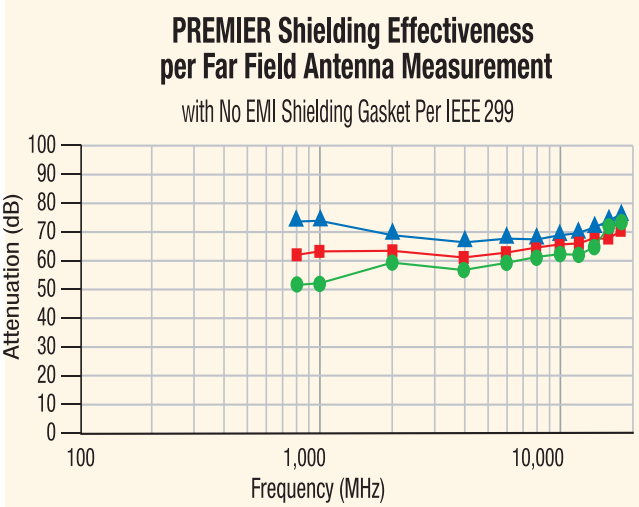
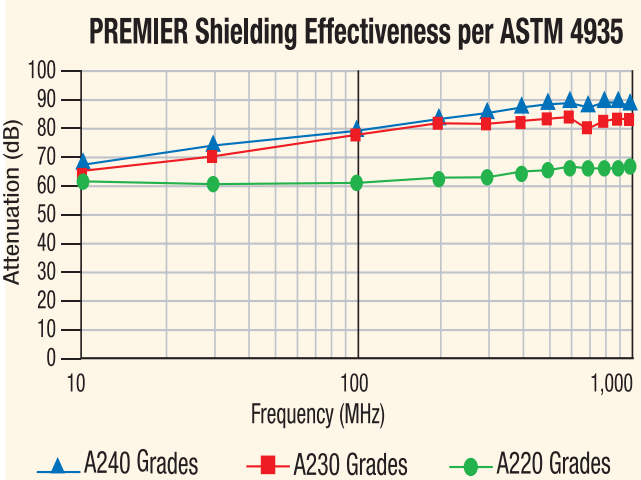


Figure 5: Joints/Seams

Shielding Effectiveness Performance







Figures 6-8: PREMIER shielding effectiveness performance

Mechanical Properties

Due to an even dispersion of long Ni-C fibers, PREMIER™ parts have exceptional tensile and flexural properties. Injection molded PREMIER parts provide excellent durability against mechanical shock and vibration similar to performance of composites used in the aircraft industry. This high performance allows PREMIER to be considered as a replacement for metal parts and still deliver the needed mechanical performance. A listing of typical properties appears in Table 2.

Material Property Stability

PREMIER materials retain their superior performance after rigorous life testing. Testing has included 1,000 hours at RTI and 85% relative humidity, 1,000 hours dry heat at RTI with mechanical, thermal cycling (IEC 68-2-14) and thermal shock testing (IEC 68-2-30). Results show greater than 95% retention of typical properties for electrical, shielding effectiveness and mechanical properties. For a test report contact Chomerics.

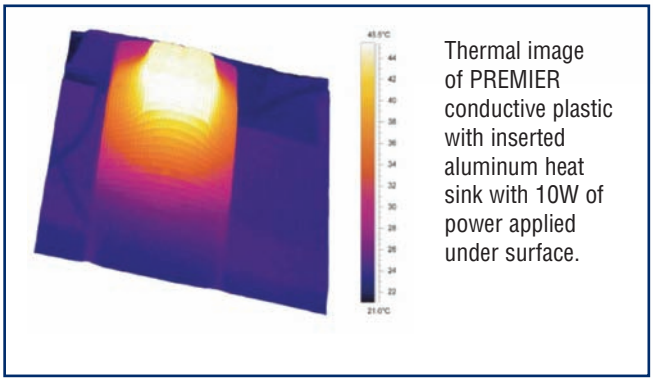
Corrosion Resistance

The corrosion resistance of PREMIER is exceptional, making it an excellent choice for outdoor applications in harsh enviroments. After 360 hours of salt fog exposure (35°C at 95% relative humidity of a 5% NaCl solution, ASTM B117) electrical and shielding effectiveness was virtually unchanged. This performance is the direct result of the intrinsic corrosion resistance of the highly stable nickel plated carbon fiber and nickel graphite powder used in PREMIER. Now EMI shielded housings no longer require costly painting or plating secondary operations to obtain stability in harsh environments.

Thermal Management Capabilities

Ni-C fibers act as thermal conductors, thus PREMIER plastics have inherent thermal conductivity properties as high as 0.70 W/m-K. (See Table 2). This allows PREMIER parts to be used within many thermal management systems.

Thermal conductivity results improve when an insert molded metal heat sink or spreader is used with a PREMIER part to maximize heat dissipation. Tests by Chomerics show that by embedding an aluminum heat spreader/heat sink into Ni-C filled PREMIER plastic, significant reductions in junction and skin temperatures result. Transistor power also increases when compared to results using a non-conductive PC/ABS plastic. The image in Figure 9 demonstrates effective thermal management of a 10W source. Heat spreaders and heat sinks can be used with PREMIER parts by attachment with Chomerics' THERMATTACH®, double-sided, thermally conductive adhesive tape or THERMAGAP™, thermally conductive gap fillers.



Thermal image of PREMIER conductive plastic with inserted aluminum heat sink with 10W of power applied under surface.

Figure 9: Effective thermal management with 10W source

Weight Savings

PREMIER parts can weigh up to four times less than commonly used metal parts. The density of PREMIER at 1.2 to 1.4 g/cc is one-half the density of aluminum (2.7 g/cc), and far less than other commonly used metals. PREMIER's light weight, coupled with the ability to mold walls as thin as 1.0 mm or one-half as thick as Al die castings allow PREMIER parts to weigh 75% less. Although PREMIER must have thicker walls than a stamped-bent metal stainless steel part due to the large reduction in density, PREMIER can weigh 50% less than the stainless steel part. For weight sensitive transportation or hand held device applications, PREMIER can help yield weight reduction and save cost.

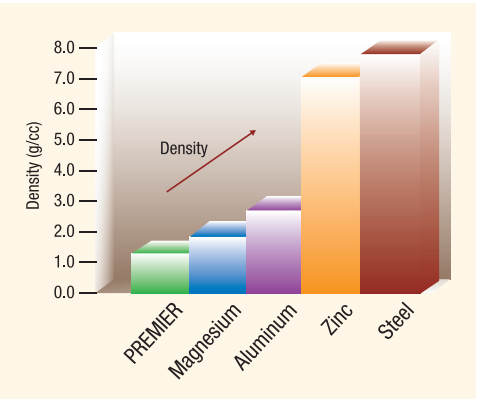


Figure 10: Density Comparison

Table 2: Typical Properties — PREMIER™ EMI Shielding Plastics

Property	Test Method	Units	A220-HT	A230-HTHF	A240-HTHF	A220-FR	A230-FRHF	A240-FRHF	A220-ST	A230-ST	A240-ST
Filler Level			Low	Medium	High	Low	Medium	High	Low	Medium	High
Electrical											
Surface Resistance		Ohm/sq	4.50	0.60	0.25	4.50	0.60	0.25	4.50	0.50	0.20
Through Resistance		Ohm	0.800	0.060	0.030	0.800	0.060	0.030	0.800	0.060	0.030
Mechanical											
Tensile Strength @ Break	ASTM D638	MPa (psi)	67.6 (9,800)	71.0 (10,300)	71.7 (10,400)	68.3 (9,900)	71.0 (10,300)	71.7 (10,400)	78.6 (11,400)	88.3 (12,800)	91.0 (13,200)
Tensile Elongation @ Break	ASTM D638	%	1.00	1.20	0.50	1.00	1.20	0.50	1.65	1.02	0.50
Tensile Modulus	ASTM D638	GPa (psix10^6)	5.8 (0.84)	6.7 (0.97)	7.7 (1.17)	7.5 (1.00)	6.7 (0.97)	7.7 (1.17)	6.0 (0.88)	11.1 (1.62)	15.6 (2.27)
Flexural Strength	ASTM D790	MPa (psi)	110 (15,900)	100 (15,000)	113 (16,400)	109 (15,800)	95 (13,700)	100 (15,000)	121 (17,600)	131 (19,000)	152 (22,000)
Flexural Modulus	ASTM D790	GPa (psix10^6)	5.2 (0.75)	6.3 (0.91)	8.0 (1.10)	5.2 (0.75)	6.3 (0.91)	8.0 (1.10)	5.4 (0.79)	8.1 (1.18)	11.9 (1.75)
Izod Impact (Unnotched)	ASTM D256	J/m (ft-lb/in)	197 (3.69)	176 (3.30)	192 (3.60)	197 (3.69)	176 (3.30)	192 (3.60)	298 (5.59)	233 (4.37)	234 (4.39)
Izod Impact (Notched)	ASTM D256	J/m (ft-lb/in)	74.7 (1.40)	53.3 (1.00)	64 (1.20)	58 (1.10)	53.3 (1.00)	64 (1.20)	77 (1.45)	93 (1.75)	120 (2.25)
Thermal											
Thermal Conductivity	ASTM D5470	W/m-K	0.56	0.59	0.70	0.56	0.59	0.70	0.56	0.59	0.70
HDUL @ 18.2 bar (264 psi)	ASTM D648	˚C (˚F)	122 (251)	120 (248)	118 (244)	70 (158)	80 (176)	85 (185)	128 (262)	123 (253)	119 (246)
CLTE	ASTM D696	m/m/˚C x10^{-4} (in/in/˚Fx10^{-4})	0.26 (0.14)	0.30 (0.17)	0.18 (0.10)	0.28 (0.16)	0.30 (0.17)	0.18 (0.10)	0.29 (0.16)	0.15 (0.08)	0.13 (0.07)
Physical											
Specific Gravity	ASTM D3763		1.20	1.39	1.40	1.20	1.39	1.40	1.20	1.31	1.40
Flammability	UL 94	@ 1.5 mm	N/A	N/A	N/A	V0	V0	V0	N/A	N/A	N/A

Legend: CLTE - Coefficient of Linear Thermal Expansion
HDUL - Heat Distortion Temperature Under Load
RTI - Relative Temperature Index

Molding with PREMIER™

Parts can be molded with wall thicknesses down to 0.8 mm and localized areas can be 0.5 to 0.8 mm thick. Generally, larger parts require wall thicknesses greater than 0.8 mm to facilitate flow. As with any injection molded part, flow leaders or internal walls can be used to promote flow and minimize wall thicknesses. Part designs should take into account all standard practices to avoid sink marks and put radii in corners. Gates should be located to minimize any negative cosmetic effects of gate vestige as with any fiber reinforced thermoplastic system.

Equipment Requirements

- PREMIER does not require specialized injection molding equipment. However Chomerics recommends using a press with as large a daylight clearance as possible to allow room for a hot runner system and a valve gate manifold, if needed.
- In order to control PREMIER processing parameters a closed loop control system for injection speed, injection pressure, feed throat control and back pressure is strongly recommended. A process variable recording system tied to inspection data is a very helpful tool for trouble shooting production.
- Shot size should be 30 to 80% of barrel size and a variety of screw diameters should be available to ensure compliance. A hardened general purpose screw with a diameter greater than 22 mm and compression ratio of 2.30:1 to 2.50:1 is recommended. For example, an Engle press screw with a 280 mm feed zone/225 mm transition zone/140 mm feed zone with a 25 mm nominal screw diameter and 2.35:1 compression ratio works well. The injection molding equipment should have a free flow check ring. Do not use magnet in feedthrough hopper.

Injection Molding Tooling

- PREMIER works well with injection molding tooling made in accordance with SPE/SPI Class 101 tooling standards. For production tooling, a prehardened steel should be used (S7 or H13) and depending on part specifications 1,000,000 shots per cavity may be expected. Experience to date shows no excessive tool wear. For prototyping of less than 1,000 pieces, a mild tool steel is preferred or aluminum tooling may be used.
- PREMIER is not highly abrasive to tooling, and a minimum of one million shots is achievable as molds perform similarly to those produced to run glass-filled polycarbonate.
- Textured or EDM cavity surfaces are acceptable. Draft angles of 1.5˚ to 2.0˚ are recommended for EDM or SPE/SPI #2 cavities. Higher draft angles are recommended for textured surfaces and design should follow low shrink material guidelines (Table 3).
- Cold runners with sub-gating, edge gating or fan gating will lower tooling costs and produce runner scrap. Hot runners with valve gating or direct gating will avoid runner scrap and raise tooling costs. Since runner scrap may be re-ground and re-used (by nibbling process) at a 15% level, the choice as to hot or cold runner system is the same as with any injection molding tooling choice. A cost justification should occur to determine the most economical runner system based upon anticipated run quantity.
- Chomerics will provide tool design and tool manufacture upon request.
- As with any design, a mold flow analysis should be used to validate material flow within the tool and ensure proper fill.
- Valve gating is a viable option. Direct gating is preferred. A sub-gate design will provide little or no gate vestige, and when combined with a nylon tip, excellent processing is obtained.
- Gating systems like those used with glass fiber-filled polymer work well. Recommended gate size is between 0.81 mm^2 and 4.10 mm^2 (0.00126 in^2 and 0.00636 in^2). A sub-gate diameter of 0.06 to 0.07 in. has been successful for multi-cavity or multi-gated parts. Smaller subgates may be used for single-gated and single-cavity parts.
- PREMIER mold filling and warp data are available from Chomerics.
- PREMIER materials are not designed for cosmetic applications. Surface appearance of the high fiber content materials (A240-HTHF & A240-ST) can be improved with additional mixing. Additional mixing with increased back pressure, a small diameter nozzle tip, and increased injection speeds have shown to exhibit little or no effect on resistance or shielding properties. Additional mixing is generally not necessary with the low fiber content materials (A220-HT, A220-FR, & A220-ST).

Table 3: Shrink Rate

	Shrink Rate (%)
A220-FR	0.25
A230-FRHF	0.25
A240-FRHF	0.25
A220-HT	0.25
A230-HTHF	0.25
A240-HTHF	0.20
A220-ST	0.25
A230-ST	0.15
A240-ST	0.10

Table 4: Typical Processing Parameters — Injection Molding Processing

	Units	A2XX-HT	A2XX-HTHF	A2XX-ST	A220-FR	A2XX-FRHF
Drying Temperature	˚C (˚F)	82 to 87 (180 to 190)	87 to 95 (190 to 200)	95 to 100 (200 to 210)	65 to 70 (150 to 160)	85 to 90 (185 to 195)
Drying Time, Typical	hours	3 to 4	3 to 4	3 to 4	4 to 5	4 to 5
Drying Time, Maximum	hours	8	8	8	8	8
Suggested Maximum Moisture	%	0.04	0.04	0.04	0.04	0.04
Rear Temperature	˚C (˚F)	255 to 270 (490 to 520)	255 to 270 (490 to 520)	260 to 275 (500 to 530)	250 to 265 (480 to 510)	255 to 270 (490 to 520)
Middle Temperature	˚C (˚F)	255 to 270 (490 to 520)	255 to 270 (490 to 520)	260 to 275 (500 to 530)	250 to 265 (480 to 510)	255 to 270 (490 to 520)
Front Temperature	˚C (˚F)	255 to 270 (490 to 520)	255 to 270 (490 to 520)	260 to 275 (500 to 530)	250 to 265 (480 to 510)	255 to 270 (490 to 520)
Nozzle Temperature	˚C (˚F)	255 to 270 (490 to 520)	255 to 270 (490 to 520)	260 to 275 (500 to 530)	250 to 265 (480 to 510)	255 to 270 (490 to 520)
Processing (Melt) Temperature	˚C (˚F)	255 to 270 (490 to 520)	255 to 270 (490 to 520)	260 to 275 (500 to 530)	250 to 265 (480 to 510)	255 to 270 (490 to 520)
Mold Temperature	˚C (˚F)	41 to 49 (105 to 120)	41 to 49 (105 to 120)	41 to 49 (105 to 120)	41 to 49 (105 to 120)	41 to 49 (105 to 120)
Back Pressure	bar (psi)	> 20 (> 300)	> 20 (> 300)	> 20 (> 300)	> 20 (> 300)	> 20 (> 300)
Clamping Pressure	MPa/cm^2 ($tons/in^2$)	40 to 70 (3 to 5)	40 to 70 (3 to 5)	40 to 70 (3 to 5)	40 to 70 (3 to 5)	40 to 70 (3 to 5)
Screw Speed for 25 mm (1 in) diameter at 95 to 130 rpm	cm/min (in/min)	760 to 1,000 (300 to 400)	760 to 1,000 (300 to 400)	760 to 1,000 (300 to 400)	760 to 1,000 (300 to 400)	760 to 1,000 (300 to 400)

Insert and Two-Shot Molding

Insert molding is an excellent choice to eliminate post molding assembly of non-PREMIER™ components onto or into the unit. Heat sinks, honeycomb vents, fasteners and inserts can all be incorporated without the added cost of a secondary operation.

Two-shot molding to provide areas of non-conductive material in a PREMIER part or vice versa can be accomplished using standard two-shot molding equipment and tooling. In this manner selective application of PREMIER can take place to provide selective electrical isolation, cosmetic surface, or color matching. Often two or more parts can be combined, reducing assembly complexity, inventory, and costs.

Post-Molding Operations

Once molded, PREMIER™ parts can be further processed like any thermoplastic material.

Painting parts can provide a cosmetic finish. As with any long fiber, filled polymer system the only method to reach a highly cosmetic finish or to color match to a standard is through the application of a surface coating. The choice of coatings that are compatible with PREMIER is limitless; cross linked urethane coating is a recommended choice. Contact Chomerics for assistance in material choice.

Labeling using silk screening, pad printing or decal application are all possible and do not affect the performance of PREMIER. Standard materials and application techniques for traditional thermoplastics can also be used with PREMIER. As with all thermoplastics, part identification or other labeling can be accomplished by cavity marking either negative or positive.

Sonic or vibration welding for assembly of PREMIER to itself, and other like thermoplastics is an excellent attachment method. Testing indicates a 77° energy director butt joint design gives a tensile strength equivalent to base material. Lap joints and double shear joints can be used effectively with tensile strength within 10% of base material. Specific designs will vary based upon part configuration — contact Chomerics for assistance.

Heat staking of threaded inserts can be done per standard procedures. Chomerics has worked with Emhart Technologies Dodge® Ultrasert II threaded inserts successfully and recommends their use. Blank hole sizes as recommended by Dodge should be used and can be obtained for all insert sizes from Dodge. It is believed any insert designed for use with a filled thermoplastic will work with PREMIER. For design assistance contact Chomerics or Dodge directly.

Thread forming screws can also be used to reduce cost for applications that do not require many openings and closings, eliminating the need for threaded inserts. Many commercially available screws can be used. Chomerics has performed testing with and recommends Delta PT grade screws. Hole diameters for the thread form should be 85% of the thread maximum diameter.

WARNING – USER RESPONSIBILITY

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

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2. Product Selection. If Seller has provided Buyer with any component and/or system recommendations, such recommendations are based on data and specifications supplied to Seller by Buyer. Final acceptance and approval of the individual components as well as the system must be made by the Buyer after testing their performance and endurance in the entire application under all conditions which might be encountered.

3. Payment: Payment shall be made by Buyer net 30 days from the date of delivery of the items purchased hereunder. Any claims by Buyer for omissions or shortages in a shipment shall be waived unless Seller receives notice thereof within 30 days after Buyer's receipt of the shipment.

4. Delivery: Unless otherwise provided on the face hereof, delivery shall be made F.O.B. Seller's plant. Regardless of the method of delivery, however, risk of loss shall
pass to Buyer upon Seller's delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

5. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 365 days from the date of shipment to Buyer. THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.

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7. Inspection: Seller shall be given the opportunity to correct or replace defective products prior to cancellation. Final acceptance by Buyer shall take place not later than 90 days after shipment.

8. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order; however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

9. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller that is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

10. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

11. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefor upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

12. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade secrets or similar rights except as provided in this Part 12. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, and trade secrets (hereinafter 'Intellectual Property Rights'). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 12 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights. If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade secret or any similar right.

13. Export Limitations. The items sold hereunder are authorized by the U.S. government for export only to the country of ultimate destination indicated on the face hereof for use by the end-user. The items may not be transferred, transshipped on a non-continuous voyage, or otherwise be disposed of in any other country, either in their original form or after being incorporated into other end-items, without the prior written approval of the U.S. government.

14. Commercial Items. Unless otherwise indicated on the face hereof, the items being sold hereunder if sold for military or government purposes constitute Commercial Items in accordance with FAR 2.101, and as such the assertions delineated in the DFAR's 252.227-7013, 252.227-7014, 252.227-7017 and FAR 52.227-15 (c) shall not apply to this contract. Additionally, in view of the Commercial Item status, any deliverable technical data and/or computer software to be provided will contain Seller's normal commercial legend subject to the restrictions contained therein.

15. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

16. PREMIER™ Conductive Plastics: Parker Chomerics™ PREMIER™ conductive plastics are sold under license solely for use in the following applications: (i) EMI/RFI shielding, i.e., electromagnetic and/or radio frequency interference shielding or compatibility and surface grounding therefore; (ii) earth grounding, corona shielding, and anti-static and/or electrostatic discharge protection shielding; and (iii) as thermally conductive members to dissipate heat generated by electronic devices.

The resale of PREMIER™ conductive plastics in pellet or any other raw material form is expressly prohibited, as is their use in any application other than as stated above, and any such resale or use by you or your customers shall render any and all warranties null and void ab initio.

You shall defend, indemnify, and hold Parker Hannifin Corporation and its subsidiaries (Parker) harmless from and against any and all costs and expenses, including attorney's fees, settlements, and any awards, damages, including attorney's fees, and costs, resulting from any claim, allegation, suit or proceeding made or brought against Parker arising from any prohibited use of PREMIER™ conductive plastics by you or your customers.

17. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

NOTE: Please consult your local Chomerics office for Terms of Sale applicable in the country in which your order is placed.

Global Capabilities

Chomerics, a division of Parker Hannifin Corporation, is the first choice for EMI (electromagnetic interference) shielding materials. Our core strengths include unparalleled design capabilities, innovative technology, and global service and support. Since 1961, Chomerics has been the leader in the development and application of conductive elastomer technology in extruded, molded and RTV compound forms, and with form-in-place gasketing technology. EMI shielding materials include conductive elastomers; metal EMI gasketing; spring finger gaskets; EMI cable shielding; conductive coatings and adhesives; shielding laminates and foil tapes; and shielded vents and windows.

We also manufacture an innovative line of thermal interface materials. Chomerics products have been designed into thousands of applications and help assure the performance, integrity, survivability, and maintainability of communications equipment, radar, aircraft, defense, aerospace, computers, fire control systems, consumer and commercial electronics.

Our comprehensive EMI testing facilities provide us constant exposure to real-world problems. We respond to your shielding challenges with cost-effective solutions.

Use Chomerics' lead vendor experience for managing the complete supply chain for your shielded housings. The many benefits include enhanced quality and accountability, together with streamlined production and scheduling. Call or email Chomerics for reliable advice on material selection and design that can help ensure the success of your products.

In addition to PREMIER™ Conductive Plastic, Chomerics offers the following full range of EMI shielding and thermal management solutions:

- EMI shielding and electromagnetic compliance testing
- Conductive elastomers – molded, extruded and form-in-place (FIP)
- Conductive foam based gaskets – Fabric-over-foam and z-axis foam
- Conductive compounds – Adhesives, sealants and caulks
- Coatings – ECOPLATE® direct metallization and conductive paints
- Metal gaskets – Spring fingers, metal mesh and combination gaskets
- Foil laminates and conductive tapes
- EMI shielding vents – Commercial and military honeycomb vents
- Shielded windows
- Cable shielding – Ferrites and heat-shrink tubing
- Microwave absorbing materials

Thermal Control

- Phase change pads
- Gap filling sheets, pad and compounds
- Thermally conductive adhesive tapes
- Insulator pads
- Heat spreaders
- Thermal grease

The Chomerics world headquarters facilities in Woburn, Massachusetts are certified to ISO 9001 standards. The Chomerics facility in Marlow, UK is ISO 9001 and ISO 14001 certified. The Chomerics thermoplastics injection molding facility in Fairport, NY is ISO/TS 16949 certified.

> Global Locations

Chomerics North America

Parker Hannifin Corp.
77 Dragon Court
Woburn, MA 01801 USA
Tel: + (1) 781 935 4850
Fax: + (1) 781 933 4318
chomailbox@parker.com

Chomerics Europe

Parker Hannifin PLC
Parkway, Globe Park
Marlow, Bucks, SL7 1YL
United Kingdom
Tel: + (44) 1628 404000
Fax:+ (44) 1628 404091
chomerics_europe@parker.com

Chomerics South America

Parker Hannifin Ind. e Com. Ltda.
Seals Division
Via Anhanguera, KM 25,3 - Perus
05276-977- São Paulo - SP, Brazil
Tel: + (55) 11 3917 8544
Fax: + (55) 11 3917 8563

Chomerics Asia Pacific

Parker Hannifin Hong Kong Ltd.
8/F. Kin Yip Plaza 9 Cheung Yee St.
Cheung Sha Wan, Kowloon,
Hong Kong
Tel: + (852) 2428 8008
Fax: + (852) 2786 3446
chomerics_ap@parker.com

CHOMERICS Parker

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www.chomerics.com