Connectors Packaging

The overall connector design can be considered a package, with variations within each design that determine its ultimate configuration and attributes. To this end, the following is an elaboration on the individual parts that are selectively chosen to make up the various connector packages (designs) discussed under Technologies.

Materials

Materials for the connector contact, insert, and shell, are all chosen to accommodate very specific design and cost requirements for the intended use application.

Contacts

Contacts are the heart of the connector design and the material choices are:

a. Beryllium copper – The best electrical conductor of any spring alloy of comparable hardness. It is stronger and more resistant to fatigue than any other copper alloy. It has excellent corrosion resistance (comparable to pure copper) and a wide operating temperature range (sub zero to +149°C).

b. Phosphor Bronze – Alloy grades A and C are widely used for its good corrosion resistance and fair electrical conductivity. It is a good general-purpose material for those applications below +107°C. Alloy C is preferred for its moderately high mechanical properties. Alloy A is chosen for its lower cost when technically acceptable.

c. Spring Brass – Popular for low-cost applications where high temperature or high mechanical stresses are not a consideration. It is often used in combination with Beryllium Copper contacts to enhance the spring tension contact when mated.

d. Low Leaded brass – Often the preferred rod stock for male pins chosen for ease in its machining. It has good electrical properties and is resistance to corrosion and stress cracking. It is often used in combination with Beryllium Copper contacts to enhance the spring tension contact when mated.

Inserts

Insert material is chosen for the lowest cost per unit volume of the connector, and the shortest molding cycle, while still meeting all of the electrical, mechanical, thermal and chemical parametric requirements of the intended use application. An important consideration often overlooked is the chemical compatibility of the insert, with the cleaning agents used in the subsequent manufacturing soldering processes. MIL-M-14 is a valuable reference for severe environments and can be useful in less demanding applications. Table 1 lists some of more the popular insert materials and their recommended temperature ranges. The use of insert material beyond published ratings by the manufacturer is not recommended. For those special applications that may tolerate over-heating of materials for shorten operational life, the manufacturer should be consulted as an additional insight may be offered.

Shells and Associated Hardware

Shells and associated hardware for mounting, indexing, and securing are manufactured from a limited number of materials. Shells and hoods are usually sheet or die-cast Aluminum, but sometimes cold-roll or stainless steel is used, which are often the preferred materials for locking devices, cable clamps, guide pins and jack screws. Brass is also used for guide pins and miscellaneous assembly screws.

Plating and Coatings

Plating and coatings are selected for both durability and corrosion resistance, and sometimes, appearance. Connector shells are often anodized but chromate, tin, cadmium plating, and paint are also used. For appearance, a clear chromate over cadmium plating provides a bright, silver like finish. Contact plating is necessary to ensure continued acceptable conductivity as the connector ages and is repeatedly mated and disengaged. Both wear and corrosion are factors affecting the useful connector life. The plating choices are dependent on the connector design and its intended use. A common plating methology uses hard gold on the sockets and soft

Table 1. Common Insert Materials

Material Types (Common Names)	**Temperature Range* (C)**
Diallyl phthalate	-50 to +200
Ceramic	-55 to +590
Epoxy resin	-40 to +157
Ethylene Propylene	-40 to +105

Kel-F (CTFE)	-55 to +150
Fluorosilicone	-55 to +200
Melamine	-55 to +130
Mica-filled Bakelite	-55 to +150
Neoprene	-55 to +120
Nylon	-55 to +120
Polyamide	-40 to +100
Polyethylene	-55 to +80
Polyimide	-55 to +250
Polystyrene	-55 to +85
Polysulfone	-55 to +150
Rexolite	-55 to +85
Silicone rubber	-55 to +200
Teflon (FEP)	-55 to +200
Teflon (TFE)	-55 to +250
Vitreous glass	-55 to +250
Polychloroprene	-55 to +120

*NOTE: Values are based on best available data from a variety of sources. Manufacturers should be consulted for specific design applications. Also, see listing in the Connector Design and materials section for supplier names and related trade names.

gold on the pins, which provides a burnishing action as the interfaced contacts move. The under plating or flash is also important, as thin or porous gold over nickel or silver is a problem, with long time storage of contacts in high sulfur atmospheres, and/or for connectors exposed to high ambient operating temperatures (e.g. automotive under-hood). Nickel has an advantage over silver, as it does not oxidize as readily as the silver sulfides when exposed. Nickel oxide and silver sulfide is always a conductivity concern, and silver sulfide is a problem in RF applications as the sulfides that tend to form on the skin of the plating induce significant RF impedance into the circuit, especially at microwave frequencies.

Contact/Insert Assemblies

Contact/insert assemblies with captive inserts and solder cups are still used, however, crimp-type insertable/removable contacts are now preferred in many applications to eliminate solder problems and to facilitate repair or changes in contact arrangement. These designs are available with variations in insertion/withdrawal techniques and contact entry configurations. Circuit board edge connectors and some blade-type contacts have a single tine that snaps against a shoulder in the molding and is easily inserted by hand and removed with a simple tool. The retention systems for pin and socket contacts and entry designs are described below.

Retention Systems

Two popular retention systems are described in paragraph a. and b. Other retention systems are described in c and d.

a. A collar with spring tines is incorporated into the contact and when inserted, snaps against a shoulder in the insert. Insertion is accomplished by hand or with a tool, and withdrawal is done with a tool.

b. The contact is grooved and inserted into a resilient insert material, which fills the groove, and retains the contact. Simple insertion and removal tools are required.

c. REMI™ has a unique design, consisting of a metal retention sleeve, molded into the insert that accepts either male or female contacts, which snap in place with finger pressure and are removed with a tool. This feature places insertion/withdrawal stresses on the two metal pieces rather than the insert material.

d. The Little Caesar™ retention system incorporates a resilient wafer with a cone configuration that expands and then snaps back against the rear contact shoulder to hold the contacts in place. Insertion and withdrawal are from the rear using a simple tool.

Entry Configurations

Entry configurations are either closed or open; each provide spring pressure ensuring continuity, by keeping the pin and socket in intimate contact. Open entry designs are more susceptible to damage of the female contact when poor alignment occurs or by insertion of a test probe. Closed entry designs reduce this possibility of damage, as they incorporate a solid ring that guides the pin into the socket. Spring pressure is accomplished either by incorporating a spring-loaded feature in the socket that presses against the inserted pin, or by a pin that has a slightly larger diameter than the socket, but is of a compressible configuration.

Crimp Connections

Crimp connections are a cost effective and reliable method for attaching the electrical connector contacts to applicable electrical wiring. Since there is no heating at the juncture, thermal damage to the insulation or small wire/contacts is eliminated. The proper tool selection and set-up for a given style crimp of the correct size for a given wire size is imperative. When appropriate tooling is used, operator error and variations in crimp integrity is also virtually eliminated. The wrong tool, tool set-up, or size can result in over or under crimping, that will damage the wire or leave it loose. Both are unreliable connections that may result in premature failure or a latent defect. An effect check on crimp integrity can be achieved by adjusting the crimp depth, to allow the wire to withstand a minimum of 75% of the wire's tensile strength (see Table 2).

Table 2. Tensile Strengths of Crimped Wire

Wire size	Tensile strength, Lbs. (After crimping)
26	7
24	10
22	15
20	19
18	38
16	50
14	70
12	110
10	150