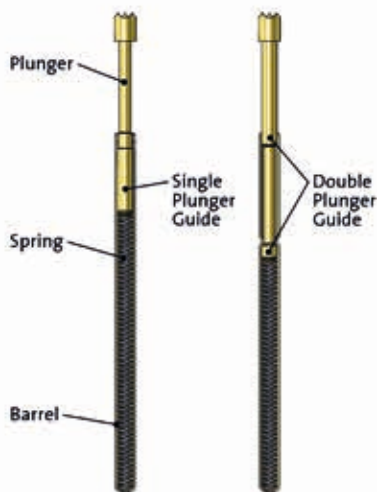


Design of a Spring Contact Probe

Spring contact probes are typically made of a plunger, a barrel and a spring. FEINMETALL is producing contact probes with single plunger guide and with double plunger guide. Probes with single guide are built with a crimped flange at the top of the barrel. These probes are regarded as international standard for ICT/FCT probes. Spring contact probes with double guide are built with a crimped flange in the upper third of the barrel. Thereby the plunger is guided at the flange and additionally at the end of the barrel.



Plunger

FEINMETALL manufactures plungers with many different tip styles, suitable for a large variety of applications (see pages 6 and 7). Plungers are generally made from beryllium copper (BeCu) or steel. Aggressive tip styles are made by a special grinding process for ultra sharp edges. Optimized turning and plating processes are resulting in an outstanding straightness and exactness of the plunger surface, the base for a long lifetime.

Barrel

FEINMETALL barrels are made of nickel-silver, bronze or brass. Nickelsilver barrels are deep-drawn whereas barrels made of bronze are turned or deep-drawn and barrels of brass are turned. All barrels are usually silver or gold plated. A small hole in the bottom permits the barrels to be thoroughly cleaned during manufacturing and ensures continuous wetting in the plating process.

Spring

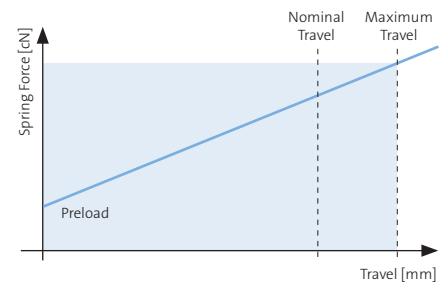
During the early years FEINMETALL developed long-life springs for the clock industry and subsequently made use of this knowledge in the manufacturing of spring contact probes. Compression springs are normally made of silver plated music wire or stainless steel, for some special applications also of non-magnetic beryllium copper. Springs made of music wire have a working temperature up to a maximum of 80°C (176°F) while stainless steel springs can be operated up to 250°C (482°F) and springs made of BeCu up to 200°C (392°F).

Spring Force

The selection of the spring force mainly depends on the application. On the one hand the spring force needs to ensure the quality of the electrical contact and the penetration of contaminations or oxide layers. On the other hand it should not lead to any damages on the contacting surface or on the board. It needs to be taken into consideration that the same spring force with one sharp tip has four times the force as a tip style with a four point crown head with four contact points. In test fixtures (especially vacuum fixtures) the sum of all spring forces has to be observed in order to close the fixture and the contacts without problems.

Spring Travel

The spring force increases proportional to the spring travel. This linear function is shown in the force-travel-diagram. During the assembly of the probe the spring is already compressed by a certain travel. The resulting spring force is called preload. The preload makes sure that there is a certain force right from the beginning of the contacting process. Also it makes sure that the plunger is completely pushed back after the contacting. The nominal spring force is the spring force at the recommended working travel. The recommended working travel should not be exceeded significantly, because otherwise the life time of the probe could be considerably reduced.



Materials and Plating

The optimum performance of a spring contact probe is significantly depending on the selection and combination of materials and plating. Developing, testing and qualifying of materials for the various applications is an important aspect of our research and development efforts.



Basic Materials

For choosing the optimum basic material for barrel, plunger, spring and receptacle of spring contact probes different aspects need to be considered. Besides the technical applicability also machining and economical facts are relevant for this decision.

Beryllium-Copper (BeCu)

combines outstanding mechanical properties with a high electrical conductivity. It is used for plungers or contact elements in a great variety of products, especially in the field of standard- and high current probes.

Also springs can be made of BeCu.

Steel

is significantly harder than BeCu and is used for plungers with aggressive tip styles or the requirement of extremely long durability.

Nickel Silver

is very resistant to corrosion and is well suitable for machining. Barrels and receptacles made of nickel silver can be deep drawn economically.

Bronze

is characterized by a combination of good wear resistance, cold formability and high electrical conductivity. It is used for barrels and receptacles.

Brass

is an extremely high quality material with very high electrical conductivity, a good wear resistance and the suitability for different ways of machining. It is used for barrels, receptacles and for special shapes.

Plating Material

Typically the surfaces of all elements of spring contact probes are galvanically plated in order to protect the basic material against corrosion. At the assembled spring contact probe the plating also reduces friction and thereby leads to low abrasion and low contact resistances. FEINMETALL plating materials are basically galvanic nickel, chemical nickel, gold, rhodium or silver. To achieve the maximum performance the ideal selection and combination of coating materials, coating thickness, coating alloys as well as various boundary processes have to be made.

Galvanic Nickel

has a good chemical durability and hardness. It is not brittle and adheres well to the base material. Nickel also prevents the base material from migrating into the precious metal surface and contaminating it.

Chemical Nickel

has a very good chemical durability and a hardness of at least 700HV ('60HRC). Chemical nickel is most appropriate for aggressive tip styles, because it has a good contouring capability and wear resistance as well as high ductility.

Gold

guarantees the best chemical durability, but its hardness is 150-200HV ('85HRB) only. Gold considerably improves the contact resistance.

Silver

is used as a bearing surface and as corrosion protection for barrels and springs. The hardness of the silver layer is 60HV ('70HRB) only, but it adheres very

well to the base material, improving the electrical conductivity.

Rhodium

is extremely resistant to wear and abrasion. Due to its hardness of 600 to 1000HV ('55 to 70HRB) it is plated on plungers which are used in very rough applications.

FM Longtime Gold

is a special gold plating for steel plungers developed by FEINMETALL. The combination of steel and FM Longtime Gold results in a high performance and a long lifetime, even at heavy load applications.

Progressive Coating

is a new coating for contacting lead-free soldering pads and other contaminated or oxidized surfaces. This coating is characterized by very low contamination of the tip and thereby it leads to a very long lifetime of the probes.

Electrical Specifications

In a contact probe the primary current flow is typically through the plunger, the barrel and the receptacle.

A secondary current flow is through the plunger, the spring and the barrel.

This leads to transfer resistances at the transition points that are influenced by the following factors:

- conductivity of the base material
- conductivity of the plating material
- condition of the surface of the probe
- size of the contact surface
- contact forces at the transition points

FEINMETALL is taking measures to guarantee a constant low contact resistance during the whole lifetime of the probes.

	Basic Materials	Plating
Barrel	Nickel silver (deep-drawn) Bronze (turned or deep-drawn) Brass (turned)	Silver Gold
Plunger	Beryllium-Copper (BeCu) Steel Synthetic Material	Chemical Nickel Gold FM Longtime Gold Rhodium Progressive Coating
Spring	Music Wire (max. 80°C) Stainless Steel (max. 250°C) BeCu (non magnetic, max. 200°C)	Silver Gold
Receptacle	Nickel Silver Bronze Brass	Gold