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White Bronze

White Bronze consists of an alloy of copper, tin and zinc. The advantages are a shiny, non magnetic, corrosion resistant, low friction surface with superb electrical and mechanical characteristics.

[\[Top\]](#)**Silver**

Silver is used to obtain the highest possible electrical performance. The only disadvantage is that it will tarnish (forming silver sulphite or nitrite) which can influence the mechanical coupling. This however, will not influence the electrical performance.

[\[Top\]](#)**Silver + White Bronze**

This plating combines the best properties of Silver and White Bronze. A silver base coat is applied to reach the best electrical performance with a top layer of white bronze to meet the mechanical and environmental requirements.

[\[Top\]](#)**Nickel**

Nickel offers good mechanical and environmental resistance. As nickel is a magnetic metal, it is not recommendable to be used for sensitive intermodulation applications. It may also cause an allergic reaction when handled. White bronze has been introduced as a suitable replacement for nickel plating of RF-connectors.

[\[Top\]](#)**Gold**

Historically Gold has always been the preferred plating for higher frequency coaxial connectors due to its excellent conductive and anti corrosive properties. Electroplated gold is a relatively soft material with microscopic holes. Prior to gold plating a base layer of copper or nickel is applied to prevent diffusion of the gold into the base material. However nickel is not recommended to be used for sensitive intermodulation applications.

[\[Top\]](#)**NiP + Gold**

NiP + Gold is recommended for applications requiring a high number of mating cycles. This plating comprises a non-magnetic nickel base layer and a thin gold surface layer. The effect of the hardness of the nickel plate base layer is to produce an increased wear resistance in the gold, whilst maintaining its excellent electrical contact properties. A considerable economic advantage is achieved due to the significant reduced gold thickness compared with the standard gold coatings.

[\[Top\]](#)**PCB mounted connectors**

There are three methods of mounting a connector onto a printed circuit board. Two require soldering techniques, the other is solder free.

1) Throughhole technology:

The printed circuit board is manufactured with plated through holes for placement of the components. Once installed, the component can be soldered into position using either manual-, wave- or reflow-soldering techniques.

Small connectors (e.g. MMCX, MCX, SMB) can be packaged on tape and reel for placement by standard SMD-pick and place machines.

Advantages:

- High mechanical stress
- Standard pcb usage
- Standard connector usage

[\[Top\]](#)**2) Surface mounted:**

Known as SMD (Surface Mount Device) or SMT (Surface Mount Technology). Before the components are placed, solderpaste is applied to the PCB pads. The board is then passed through a reflow solder oven.

Advantages:

- Placement by standard SMD-pick and place machines
- No "radiation" produced by protruding contacts
- High packing density on the PCB

[\[Top\]](#)**3) Press-fit technology:**

Connectors are mostly soldered onto printed circuit boards. Soldering however, has several disadvantages as this process creates thermal stress, requires solder to be applied and costly manufacturing installations.

The Press-fit process, a technology that is increasingly becoming accepted for good reasons, is an alternative to soldering. The Press-in parameters comply with the IEC 352 standard.

Press-fit pins and PCB's

The Press-fit connector pins can have different shapes. They consist of a spring core and are tin plated for better contact performance. IMS Connector Systems prefers the eye of the needle shape (see illustration).

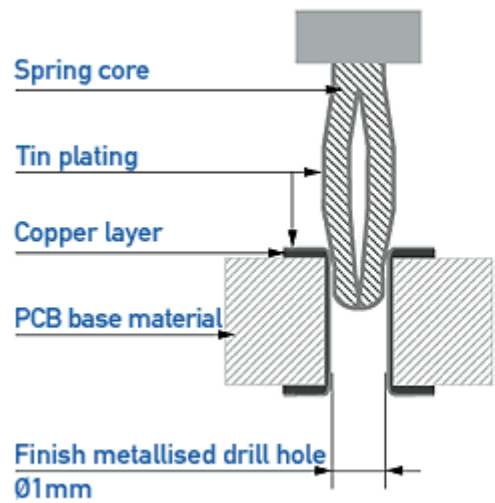
The drill holes in the PCB base material are metallised with a copper and a tin layer.

Assembly principle

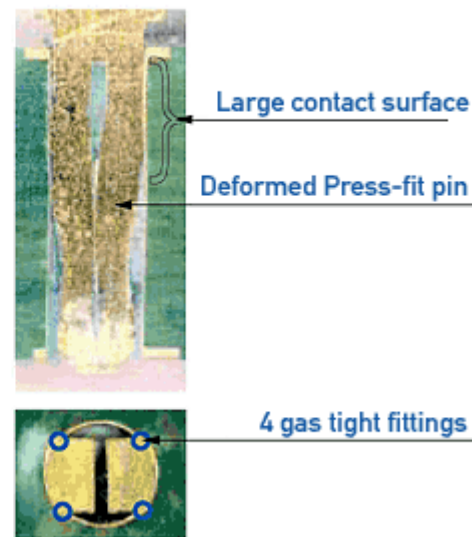
The connector's Press-fit pins are pressed into the plated through-holes of the PCB by applying mechanical force. When being pressed in, the Press-fit pins are deformed. This creates a lasting gas-tight connection between the Press-in pin and the metallised drill hole. The elastic Press-fit pins

ensure the mechanical stability and the electrical contact.

Press-fit structure



Sectional view



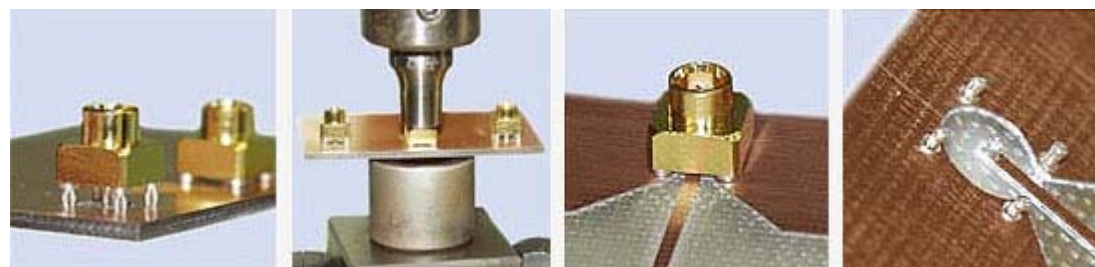
Advantages over soldering technologies

Compared with different soldering methods, the Press-fit technology offers the following advantages:

- No soldering process
- Simple and quick mounting
- Damaged components can be replaced easily
- No thermal stress
- Environmentally friendly
- Very good electrical performance
- High mechanical stability

Assembly

No costly manufacturing facilities are required for mounting Press-fit connectors. The connectors are placed onto the PCB and pressed in with a defined force (see illustration). This can be processed automatically or manually.



Before Press-in

Press-in procedure

Top view

Bottom view

Replacing connectors

The spring core Press-fit shape enables multiple insertions to be made if necessary. Unlike soldering methods, this technology neither causes thermal stress nor contamination by solder.

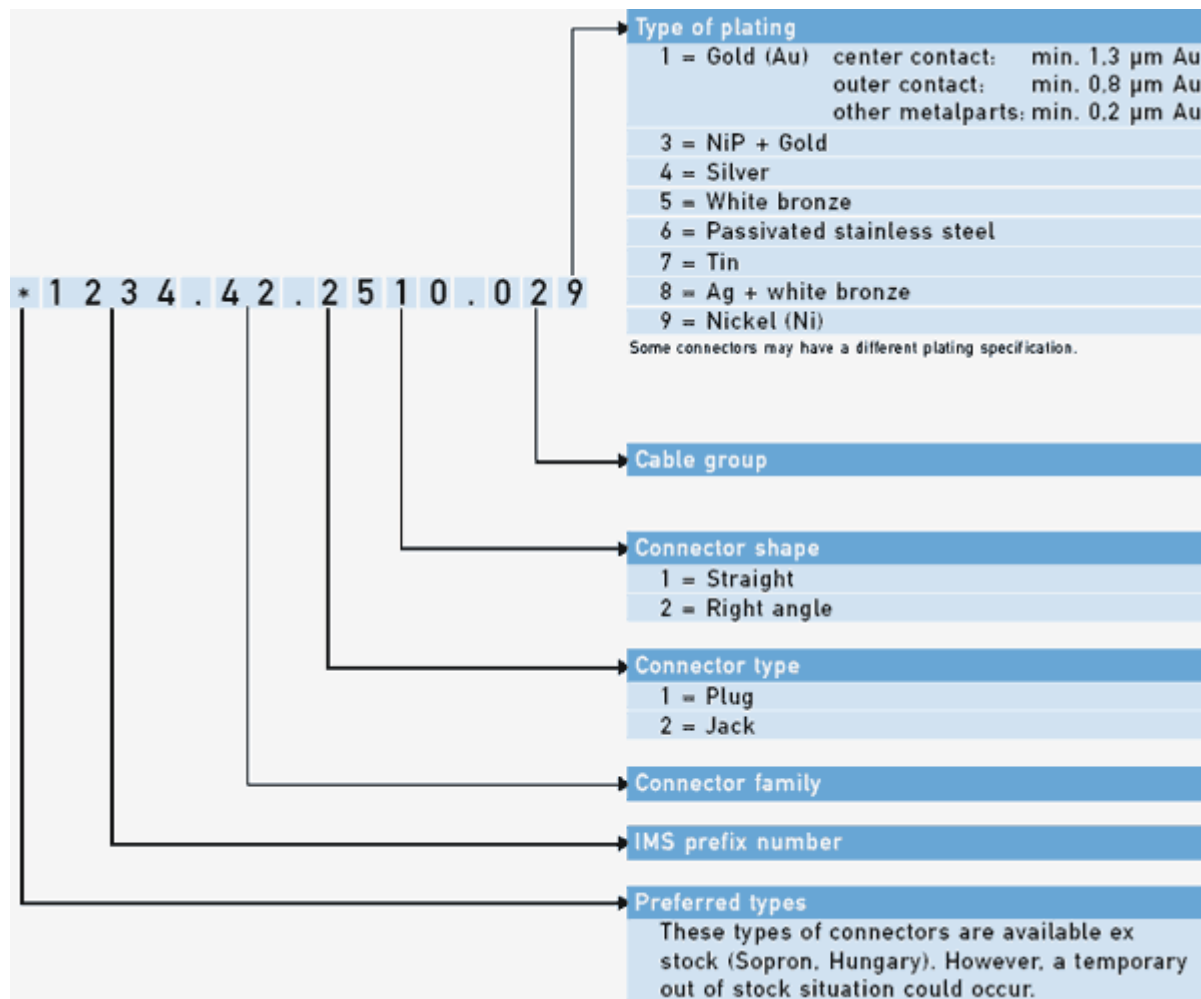
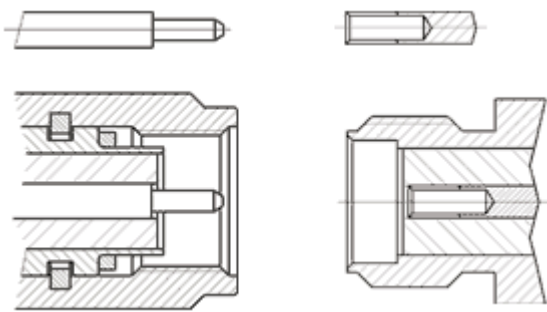
Mechanical specification	
Applies to standard	IEC 352
Max. press-in force per Press-fit pin	180 N
Min. extraction force per Press-fit pin	20 N
Press-fit pin Press-fit material Press-fit surface Press-fit shape	Bronze SnPb over Ni Lead free Eye of the needle
Printed circuit board Base material Thickness Finish metallised drill hole	FR4 or equivalent 1,5 - 3,2 mm Ø 1 mm +0,09/-0,06
Environmental specification	
Vibration	IEC 512 - 4
Long time storage	IEC 512 - 5
Operating temperature	-40° C up to + 85° C IEC 512 - 6
Climatic sequences	IEC 512 - 6
Corrosion (industry, atmosphere)	IEC 68 - 2 - 60 (method 4)

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Press-in technology for panel mounting

Traditional flange and bulkhead mounting is increasingly being replaced by the new Press-in technology. Here the connector is pressed into the panel without screwing, providing a form-fit connection. IMS Connector Systems offers this technology for all connector families.

Flange, bulkhead and Press-in designs



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Flexible cables

Flexible Cables	Type	Type	Jacket d1 (mm)	Screen d2 (mm)	Dielectric d3 (mm)	Inner Conductor d4 (mm)	Crimp Hex SW/AF (mm)	Special version SW/AF (mm)
Impedance	Z = 50 Ohm	Z = 75 Ohm						
IMS type	1127487		1,20	0,80	0,52	0,30	2,67	
Group 1	RG 178 RG 178 D RG 196 A/U ET 124899		1,80 2,40 2,10 1,50	1,30 1,80 1,20 1,08	0,84 0,83 0,84 0,89	0,30 0,30 0,30 0,30	2,67 3,25 2,67 2,67	3,25 3,25
Group 2	RG 174 RG 188 A/U RG 316	RG 179 RG 187 RX 174	2,50 2,50 2,50 2,60 2,63	2,00 2,00 2,00 2,00 2,10	1,50 1,50 1,50 1,50 1,60	0,48 0,54 0,54 0,30 0,35	3,25 3,25 3,25 3,25 3,25	
Group 3	0.9/2.25 C RTK 031	46121H133PVC BT 3002 TZC 750 24	3,60 3,50 3,20 3,55 3,55 3,70	3,10 2,70 2,60 2,85 2,85	2,60 2,25 2,10 1,95 1,95 2,05	0,30 0,90 0,80 0,32 0,32 0,31	4,52 4,52 4,30 4,52 4,52 4,52	
Group 4	Hirose U.FL-LP-066		1,32	1,10	0,66	0,24	2,67	
Group 5	RG 316 /D double braid K02252D	RD 179 /D double braid	3,20 3,00	2,40 2,50	1,50 1,50	0,23 0,54	3,65 3,65	3,25
Group 8	RG 142 B/U RG 223 /U RG 58 C/U RG 400 /U RG 393 /U RG 214 /U RG 213 /U LMR® 240 Habia Speedfoam® 400 TZC 500 25	RG 59 B/U	5,00 5,40 5,00 5,00 9,90 10,80 10,30 6,35 6,35 5,70 6,10	4,30 4,30 3,60 4,30 8,70 8,80 8,15 4,67 4,67 4,70 4,50	2,95 2,95 2,95 2,95 7,25 7,25 7,25 3,86 3,86 3,75 3,70	0,95 0,89 0,90 1,00 2,46 2,25 2,25 1,44 1,44 1,40 0,60	5,41 5,41 5,41 5,41 10,90 10,90 10,90 6,50 6,50 6,50 6,50	
Group A		Filotex® 0,25	2,60	1,90	1,45	0,26	3,25	2,95
Group B		TZC 750 24	3,70	2,85	2,05	0,31	4,52	
Group C		ST 212	3,10	2,60	1,95	0,40	3,65	3,25
Group D		Filotex® 0,4 Flex 3/75	4,22 3,70	3,40 3,30	2,38 2,30	0,41 0,40	4,60 4,60	4,52 4,52
Group E		TR-SP.127	3,80	3,10	2,35	0,51	5,41	
Group F		ST 214	6,00	4,70	3,80	0,80	6,50	
Group G		Flex 5/75	4,80	3,90	2,90	7x0,19	5,41	

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Semi rigid cables

Semi rigid cables	Type	Type	Jacket d1 (mm)	Dielectric d2 (mm)	Inner Conductor d3 (mm)
Impedance	Z = 50 Ohm	Z = 75 Ohm			
Group 6	RG 405 U UT 85 Sucoform 86 Belden 1671		2,20 2,20 2,20 2,20	1,68 1,68 1,68 1,68	0,51 0,51 0,51 0,51
Group 7	RG 402 U UT 141 Sucoform 141 Belden 1673 Habia Flexiform® 402		3,58 3,58 3,58 3,61 3,60	2,98 2,98 2,98 2,92 3,00	0,91 0,91 0,91 0,92 0,92
Group 8	UT 47 UT 250 A Habia Flexiform® 401	7,20	1,26 6,35 6,40	0,94 5,30 5,30	0,29 1,63 1,60

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Passive intermodulation in communication systems

Intermodulation products are generated when two or more frequencies are applied to a non-linear transmission element. A non-linear device is produced when the signal applied does not have a proportional ratio between current and voltage at the same time.

The frequencies of these intermodulation products are in accordance to the following equation:

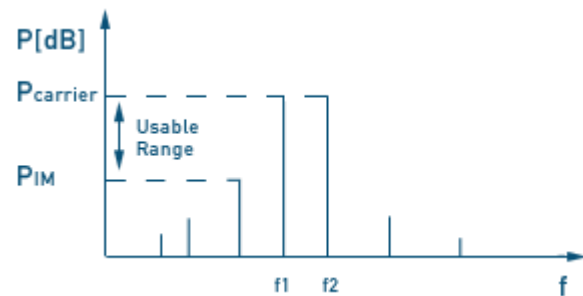
$$f_{IM} = n * f_1 \pm m * f_2 \pm p * f_3 \pm$$

with

f_{IM} intermodulation frequencies

$f_{1,2,...}$ carrier frequencies

$n,m,p,...$ integral multipliers



These mixed frequencies can cause disruption in communication systems or measuring equipment if several carrier frequencies with high intensity have the same transmission path as weak receiving signals, i.e. mobile phones.

Intermodulation in passive components is caused by very small non-linearities of the conducting parts. PIM critical elements are:

- Connectors
- Cables
- Filters
- Antennas

The reasons for non-linearities in passive devices are:

- Unsuitable contact geometry
- Use of magnetic materials (i.e. steel, nickel) in the conducting path
- Contaminated or oxidized contacts
- Dissimilar contact base materials
- Microscopic field discharging effects

The PIM-products of a system with several IM-sources i.e. cable assemblies, filters, antennas etc. can be observed. This however, is often difficult to determine because of the additive or subtractive interferences of these components. This means that the resulting IM-intensity can vary at different frequencies because of the change of the phase relations. If there is only one single component within a system with a high pin level, the performance of the entire system is affected. Due to this reason all the components in a transmission path have to be selected to suit the system requirements.

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Connector series:

It is recommended in PIM critical applications to choose the largest conducting surfaces possible in order to avoid high current densities. The design of the connector should incorporate a defined mechanical stop for the outer conductor. The use of a threaded coupling interface ensures that the interface is correctly engaged. The 7/16 and N ranges are particularly suitable for low IM applications and also the TNC and SMA type interfaces could be considered.

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Surfaces:

The use of non magnetic materials is a very important factor for low IM products. Therefore materials such as nickel and steel should be avoided. Silver and gold are recommended platings for center contacts because of their high conductivity and their contact characteristics. However, the gold layer should not have a nickel undercoating. The plating of the outer conductor is dependent on the demands of the application (i.e. corrosion properties, number of mating cycles, solderability, price). Other options are also available such as silver, white bronze or a combination of both.

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Termination technique:

To ensure the long term electrical and mechanical stability of the assembly it is essential that this operation is carried out correctly. Cable or panel mount connectors should have a full 360 degree

electrical contact of the outer conductor, preference is for the solder/clamp termination method which offers an improved PIM stability over the crimp termination variants.

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Cables:

The selection of a suitable cable is as important as the type of the connector or the termination technique used. For high power applications with high IM requirements, corrugated copper tubes or semi-rigid wires without a steel center conductor are recommended. In the majority of cases flexible coaxial cables are considered unsuitable for these applications due to their braided screening. In these cases the cable manufacturer's specification should be referred to.

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Handling:

In order to prevent the deterioration of the contact quality direct contamination with dust, salt or grease should be avoided before and after the assembling of the connector. Furthermore it is essential to protect cables and connectors from any mechanical damage.

Regarding the selection and handling of low IM connectors for different applications, IMS Connector Systems is always available to assist you with your special requirements.

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Reflections in coaxial connectors

All connectors produce signal reflections at high frequencies. This is due to a minor variation of the connector impedance to that of the overall system. These irregularities have either inductive or capacitive behaviour depending on the operating frequency and the degradation of the performance at higher frequencies. The unmatched impedances can also be caused by a combination of internal dimension changes and tolerances, material and termination techniques. Different mating interfaces can also effect the overall system performance.

The reflection performance is commonly expressed as returnloss (a), S-Parameter (S-11), the Voltage Standing Wave Ratio VSWR (s) and the reflection coefficient (r) and all three correspond to each other mathematically:

Return loss [-dB]	VSWR s	Reflection coefficient r	Return loss [-dB]	VSWR s	Reflection coefficient r
1	17,3910	0,8913	31	1,0580	0,0282
2	8,27242	0,7943	32	1,0515	0,0251
3	5,8480	0,7079	33	1,0458	0,0224
4	4,4194	0,6310	34	1,0407	0,0200
5	3,5698	0,5623	35	1,0362	0,0178
6	3,0095	0,5012	36	1,0322	0,0158
7	2,6146	0,4467	37	1,0287	0,0141
8	2,3229	0,3981	38	1,0255	0,0126
9	2,0999	0,3548	39	1,0227	0,0112
10	1,9250	0,3162	40	1,0202	0,0100
11	1,7849	0,2818	41	1,0180	0,0089
12	1,6709	0,2512	42	1,0160	0,0079
13	1,5769	0,2239	43	1,0143	0,0071
14	1,4985	0,1995	44	1,0127	0,0063
15	1,4326	0,1778	45	1,0113	0,0056
16	1,3767	0,1585	46	1,0101	0,0050
17	1,3290	0,1413	47	1,0090	0,0045
18	1,2880	0,1259	48	1,0080	0,0040
19	1,2528	0,1122	49	1,0071	0,0035
20	1,2222	0,1000	50	1,0063	0,0032
21	1,1957	0,0891	51	1,0057	0,0028
22	1,1726	0,0794	52	1,0050	0,0025
23	1,1524	0,0708	53	1,0045	0,0022
24	1,1347	0,0631	54	1,0040	0,0020
25	1,1192	0,0562	55	1,0036	0,0018
26	1,1055	0,0501	56	1,0032	0,0016
27	1,0935	0,0447	57	1,0028	0,0014
28	1,0829	0,0398	58	1,0025	0,0013
29	1,0736	0,0355	59	1,0022	0,0011
30	1,0653	0,0316	60	1,0020	0,0010

Due to the increased accuracy of cutting and solder termination of semi rigid cables, smaller impedance irregularities are achieved when compared with flexible coaxial cables. Connector styles also effect the reflection i.e. straight connectors generally produce a better performance than right angle versions. Therefore the reflection performance can vary within the same connector series dependent on style and cable.

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