



# **BALL EXPANSION PLUGS**

**Sealing Technology**



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## BALL EXPANSION PLUGS for sealing of holes

- High pressure plugs
- One single piece
- Metric and inch sizes
- Standard length
- Short length
- Interchangeable with other products
- Simple drilling
- Fast installation
- Instant mechanical expansion
- High sealing capacity
- No sealants required

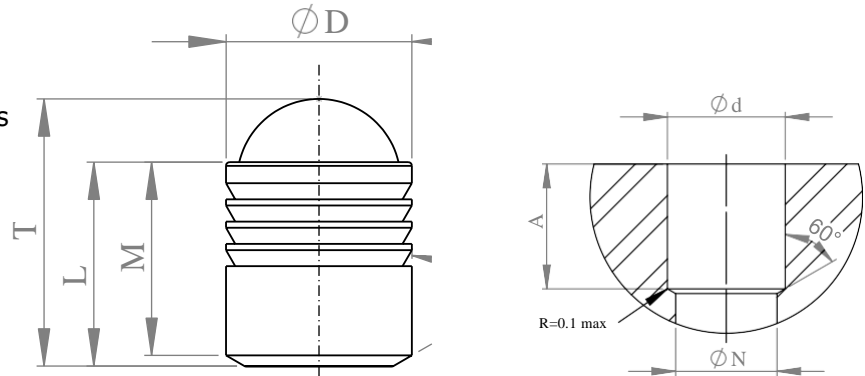


Figure 1

KSA ball expansion plugs are machined to precise tolerances and exacting quality control standards. Statistical process control (SPC) is used to ensure correct dimensions. Test to check expansion and pressure resistance are conducted on each production lot.

METRIC SIZES STANDARD LENGTH mm								
Part number	PLUG DIMENSIONS					HOLE DIMENSIONS		
	D	L	M	T	Grooves N°	d	A	N
						+0,1 0	Min.	Max.
BPMS003	3,00	3,18	2,79	4,10	3	3,00	3,40	2,20
BPMS004	4,00	4,00	3,70	5,20	3	4,00	3,80	3,30
BPMS005	5,00	5,50	5,20	6,95	5	5,00	5,30	4,30
BPMS006	6,00	6,50	6,20	8,70	6	6,00	6,30	5,30
BPMS007	7,00	7,50	7,20	10,10	7	7,00	7,30	6,40
BPMS008	8,00	8,50	8,20	11,80	8	8,00	8,30	7,40
BPMS009	9,00	10,00	9,70	13,50	9	9,00	9,80	8,40
BPMS010	10,00	11,00	10,70	14,70	10	10,00	10,80	9,40
BPMS012	12,00	13,00	12,70	17,10	12	12,00	12,80	10,60
BPMS014	14,00	15,00	14,40	20,80	10	14,00	14,50	12,70
BPMS016	16,00	17,00	16,40	23,70	10	16,00	16,50	14,70
BPMS018	18,00	19,00	18,40	26,30	12	18,00	18,50	16,70
BPMS020	20,00	22,00	21,40	30,50	12	20,00	21,50	18,70
BPMS022	22,00	25,00	24,40	34,20	12	22,00	24,50	20,70

Table 1

**Note:** Specify sleeve materials, proof pressure rating and ball materials (see page 3)

INCH SIZES STANDARD LENGTH mm								
PLUG DIMENSIONS						HOLE DIMENSIONS		
Part number	D	L	M	T	Grooves N°	d	A	N
						+0,1 0	Min.	Max.
BPES118	3,00	3,18	2,79	4,09	3	3,00	2,90	2,31
BPES156	3,97	4,09	3,78	5,33	3	3,97	3,78	3,30
BPES187	4,76	5,59	5,28	6,86	4	4,76	5,78	4,06
BPES218	5,55	5,59	5,28	7,11	5	5,55	5,28	4,83
BPES250	6,35	6,58	6,27	8,64	6	6,35	6,27	5,59
BPES281	7,14	7,59	7,29	10,16	7	7,14	7,29	6,35
BPES312	7,94	8,59	8,28	11,68	8	7,94	8,28	7,14
BPES343	8,73	10,08	9,78	13,21	9	8,73	9,38	7,92
BPES375	9,53	10,08	9,78	13,72	9	9,53	9,78	8,71
BPES406	10,32	11,10	10,80	14,97	10	10,32	10,80	9,53
BPES437	11,11	13,08	12,78	17,27	12	11,11	12,78	10,31
BPES468	11,90	13,08	12,78	18,03	12	11,90	12,78	11,10
BPES562	14,29	15,09	14,48	20,83	14	14,29	14,48	12,95
BPES625	15,88	16,99	16,41	23,11	16	15,88	16,48	14,27
BPES687	17,46	19,00	18,39	26,16	18	17,46	18,47	15,88
BPES750	19,05	22,00	21,39	29,97	20	19,05	21,46	17,48
BPES875	22,23	24,99	24,38	34,29	22	22,23	24,46	20,65

Table 2

**Notes:**

Sizes available on request

Specify material code (see page 3)

INCH SIZES SHORT LENGTH mm Low pressure								
PLUG DIMENSIONS						HOLE DIMENSIONS		
Part number	D	L	M	T	Grooves N°	d	A	N
						+0,1 0	Min.	Max.
BPSS093	2,38	2,49	1,98	3,05	3	2,38	2,06	1,78
BPSS125	3,18	3,18	2,79	4,06	3	3,18	2,87	2,54
BPES156	3,97	3,16	2,79	4,32	3	3,97	2,87	3,30
BPES187	4,76	4,75	4,24	6,10	4	4,76	4,32	4,06
BPES218	5,55	4,75	4,24	6,35	4	5,55	4,32	4,83
BPES250	6,35	5,72	4,90	7,62	5	6,35	4,98	5,59
BPES281	7,14	6,48	5,84	8,89	6	7,14	5,66	6,35
BPES312	7,94	7,11	6,40	9,91	7	7,94	6,48	7,14
BPES343	8,73	7,80	6,91	10,92	7	8,73	6,99	7,92
BPES406	10,32	9,27	7,75	13,21	9	10,32	7,82	9,53

Table 3

**Notes:**

Sizes available on request

Specify materials code (see page 3)

## Materials

Material	Sleeve	Ball	Pressure	Type
111	Trivalent case hardening steel, zinc plated passivated	Bearing steel HRc ≥ 55, heat treated, anticorrosion treatment	High pressure	Standard
311	Stainless steel AISI 303	Bearing steel HRc ≥ 55, heat treated, anticorrosion treatment	High pressure	Standard
313	Stainless steel AISI 303	Stainless steel AISI 420C	High pressure	Standard
414	Stainless steel AISI 316	Stainless steel AISI 316	Low pressure	On request
523	Aluminum	Stainless steel AISI 420C	Low pressure	On request

Table 4

## Part numbering system:

- Ball plug type           metric= BPMS, inch= BPES
- Diameter                 3 to 22 mm
- Sleeve material         1= trivalent case hardening steel, 3= AISI 303, 4= AISI 316, 5= Aluminum
- Proof pressure rating   1= high 2= low
- Ball material            1= bearing steel, 3= AISI 420C, 4= AISI 316
- Length                  0= standard length, 1= short length

## Code Example:

BPMS.004.1.1.1.0

BPMS 004 1 1 1 0

Ball plug type(metric) \_\_\_\_\_

Diameter (4 mm) \_\_\_\_\_

Sleeve material (trivalent case hardening steel) \_\_\_\_\_

Proof pressure rating (high) \_\_\_\_\_

Ball material (bearing steel) \_\_\_\_\_

Length (standard) \_\_\_\_\_

## Pressure resistance

BASE MATERIAL	Pressure bar	PLUGS MATERIAL					
		111		311		313	
		3 – 10	12 – 22	3 – 10	12 – 22	3 – 10	12 – 22
High strength steel ETG-100 AISI 1144	Test pressure	1200	900	1500	1150	1500	1000
	Working pressure	350	280	450	350	450	350
Free machining case Hard steel C15Pb DIN 1.0403	Test pressure	1200	900	1500	1150	1500	1000
	Working pressure	350	280	450	350	450	350
Cast iron GG-25 DIN 1691	Test pressure	1200	900	1500	1150	1500	1000
	Working pressure	350	280	450	350	450	350
Ductile cast iron GGG-50 DIN 1691	Test pressure	1200	900	1500	1150	1500	1000
	Working pressure	350	280	450	350	450	350
Aluminum alloy Al Cu Mg 2 DIN 3.1354/AA2024	Test pressure	1200	900	1500	1150	1500	100
	Working pressure	350	280	450	350	450	350
Aluminum alloy Al Mg Si Pb DIN 3.0625/~AA6262	Test pressure	1100	800	1300	900	1300	900
	Working pressure	320	250	380	280	380	280
Cast Al alloy G-Al Si 7 Mg DIN 3.2371/AA356-T6	Test pressure	1100	800	1300	900	1300	900
	Working pressure	320	250	380	280	380	280

Table 5

Notes: Tests conditions:  
Hole tolerance 0/+0,1 mm  
Roughness Ra  $\mu\text{m}$  1,6 Rz  $\mu\text{m}$  6,3

### Mechanical expansion and sealing capacity

Mechanical expansion takes place when the ball is pressed into the hole. The sleeve expands into the hole, sealing is achieved because of its high expansion capacity.

The holes' surface finish must be rough, low roughness reduces the plugs retention capacity.

Hardness of the plug must be higher than the base material. When the hardness of the plug is lower, increased roughness is essential.

Recommended hole roughness min. Ra  $\geq$   $\mu\text{m}$  2,5 / Rz  $\geq$   $\mu\text{m}$  10  
max Ra  $\leq$   $\mu\text{m}$  6,3 / Rz  $\leq$   $\mu\text{m}$  30

### Ball expansion plug hardness

Plug type	Hardness (min.) HB
BP/313	260
BP/311	260
BP/111	230

Table 6

### Base material hardness

Base material	Hardness (min.) HB
High strength steel ETG-100 / 44SMn28 AISI 1144	280
Case hardening steel C15Pb 1.0403	180
Grey cast iron GG-25 EN 1561	160
Ductile cast iron GGG-50 EN 1563	170
Aluminum alloy AlCu4Mg1 EN AW-2024-T3 / AA2024	120
Aluminum alloy AlMgSiPb EN AW-6012-T6 / AA6012 T6	80
Cast aluminum alloy G-AISI 7Mg EN AC-42100 / AA356	80

Table 7

## Design recommendations

### Minimum wall thickness and distance from an edge

KSA sealing plugs require a proper minimum wall thickness or distance from the block edge or from the edges of the equipment in which they are to be assembled. Below values produce only slight deformations of surfaces. Guidelines in Figure 2 meet most industrial applications.

Minimum distance from exterior walls

Minimum distance from circumference

Wall thickness between two or more holes

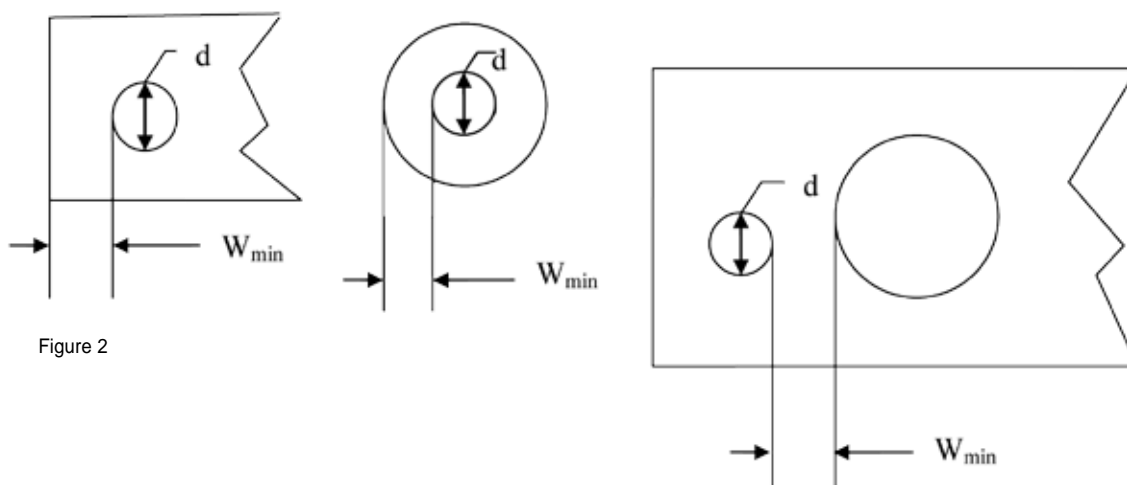


Figure 2

Values expressed below produce only slight deformation on the external wall in the range of  $< 0,03$  mm. This does not affect the performance of the KSA sealing plug.

Using  $W_{min}$  values less than those recommended can cause overloading of the base material. This can adversely influence the function of the KSA sealing plug. In these cases, tests must be run.

i.e. Expansion plugs diameters, series BP:

$$d \geq 4 \text{ mm: } W_{min} = f_{min} \times d$$

$$d < 4 \text{ mm: } W_{min} = f_{min} \times d + 0,5 \text{ mm}$$

Base material	ETG100	C15Pb	EN-GJL-250	EN-GJS-500-7	AlCu4Mg1	AlMgSiPb	G-AISI7Mg
KSA Expansion plugs series	Factor $f_{min}$ .						
BP 313	0,7	0,9	1,0	0,9	0,9	1,0	1,0
BP 311	0,7	0,9	1,0	0,9	0,9	1,0	1,0
BP 111	0,6	0,7	1,0	0,7	0,7	1,0	1,0

Table 8



### Hole design recommendations Lead-in chamfer / burr hole edge

Dimensions of the hole please see page 1 table 1, page 2 tables 2 and 3. Lead-in chamfer maximum depth is equal to 0,15 to facilitate the machining of the hole.

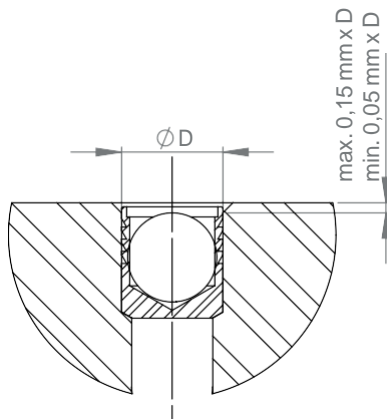


Figure 3

### Hole depth for assembly

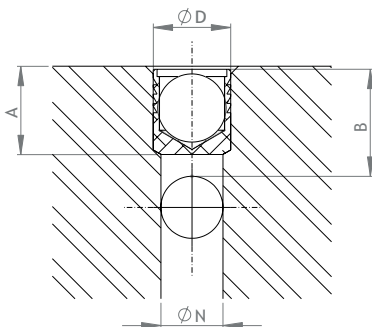


Figure 4

BPMS Series			
N max mm	D mm	A min. mm	B min. mm
2	3	3,4	5
3	4	3,8	5,5
4	5	5,3	7
5	6	6,3	8,5
6	7	7,3	9,5
7	8	8,3	11
8	9	9,8	12,5
9	10	10,8	13,5
10	12	12,8	16
12	14	14,5	18
14	16	16,5	20
16	18	18,5	22,5
18	20	21,5	25,5
20	22	24,5	28,5

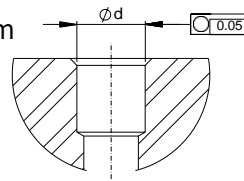
B min. = minimum distance from holes

Table 9

## Machining and installation

1) The hole is achieved with a simple drilling operation and secondary reaming is not necessary nor recommended. The obtained surface finish of the hole provides a much better plug retention and higher proof pressures, than does a reamed surface finish. Use a standard drill with 120° point. High roughness is always recommended, especially when base material hardness is greater than plug hardness, in order to achieve the highest plug retention capacity on the hole wall.  
Hole roughness  $Ra \geq \mu m 2,5 \text{ min} \leq \mu m 6,3 \text{ max} / Rz \geq \mu m 10 \text{ min} \leq \mu m 30 \text{ max}$ .

Hole roundness must be held to within 0,05 mm



Avoid surface longitudinal and spiral grooves

- 2) Check the hole dimensions, depth and diameter, and ensure it is free of cutting oils, greases, machine chips and paint. Compatibility of surface treatments must be verified each time.
- 3) Place one plug into the hole, with the ball facing out. The edge of the plug must be on the same level of the hole corner or below (See figure 5).
- 4) Press the ball into the plug using the proper KSA installation tools/equipments (see figures 6-7-8-9). The ball should be pressed below the hole edge (See figure 5).
- 5) Hand tools for hand hammer and air hammer tools available for each single size. Air hammer is suitable for all sizes.

$\varnothing$ Plug mm	Depth Min. mm	Depth Max. mm
3-14	0,2	0,5
16-18	0,3	0,7
20-22	0,5	0,9

Table 10

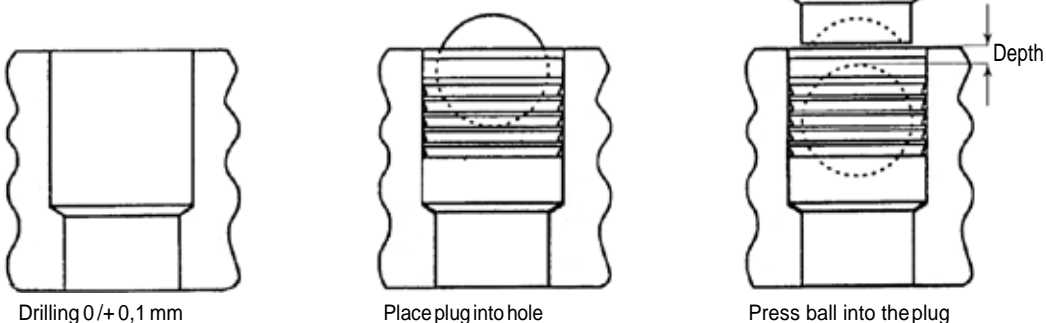


Figure 5

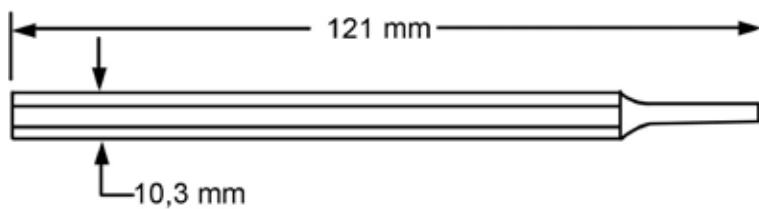
## Removal

- 1) Drill and tap threads into the steel ball.
- 2) Thread a standard bolt with striker into the steel ball and pull the ball from the plug.
- 3) Drill and tap Threads into the I.D. of the Plug. Use standard bolt with striker to pull the plug from the hole.
- 4) Check installation hole tolerances before installing a new Plug.
- 5) Contact KSA Engineering for specific drill and tap size recommendations.

## Hand installation tool

Hand tools	
Ø Plug diameter mm	Hand tool
3	PNCVTS030
4	PNCVTS040
5	PNCVTS050
6	PNCVTS060
7	PNCVTS070
8	PNCVTS080
9	PNCVTS090
10	PNCVTS100
12	PNCVTS120
14	PNCVTS140
16	PNCVTS160
18	PNCVTS180
20	PNCVTS200
22	PNCVTS220

Table 11



Semispherical edge tool for hand hammer

Figure 6 Steel: heat treated hardness  $\geq$  HRC 50

### Air hammer installation tool



KSA ITALIA MP121Q-EU Round shank air hammer

Figure 7

KSA's air hammer is built to install ball expansion plugs; high quality standards combining power and design in one package. The MP121Q-EU can deliver up to 3000 blows per minute, making it suitable for any professional.

#### MP121Q-EU key features:

- Up to 3000 blows per minute
- Shank opening: round
- Bore diameter: 19 mm.
- Long life alloyed steel barrel and heat treated piston
- Built-in power regulator and trigger control
- Stroke length: 58 mm.
- Weight: 1,59 kg

Pressure settings		
Ø Plug diameter mm	Air hammer tool	Air pressure bar <sup>1</sup>
3	PMCVTS030	2,5
4	PMCVTS040	3,0
5	PMCVTS050	3,0
6	PMCVTS060	3,5
7	PMCVTS070	4,0
8	PMCVTS080	4,0
9	PMCVTS090	4,5
10	PMCVTS100	4,5
12	PMCVTS120	5,0
14	PMCVTS140	5,0
16	PMCVTS160	5,5
18	PMCVTS180	6,0
20	PMCVTS200	6,0
22	PMCVTS220	6,0

Table 12

<sup>1</sup>Note: air pressure on the Installation point.

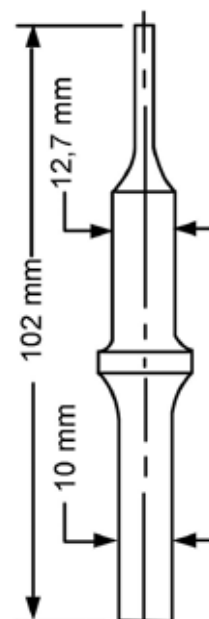


Figure 8

Semispherical edge tool for air hammer  
Steel: heat treated hardness  $\geq$  HRc 50

## HPR – HYDROPNEUMATIC PRESS for Ksa ball plugs installation

Hydropneumatic press for the installation of KSA ball plugs from  $\varnothing$  3-14 mm. The press offers a fast and correct installation. Tools available for each size, quick changeover time.

Required working stroke is fixed for each dimension.

CPU and PLC software available on request.

Manually operated hydropneumatic press series HPR with the following characteristics:

- Force 6 bar air supply
- Cylinder ram 60 mm
- Working stroke 15 mm
- Service light (rod-working plate) 250mm
- Hydraulic speed control with stop function, to increase precision of positioning.
- Operating voltage 230v/110v with automatic switch.

Electronic press control system included, with 8 predetermined strokes, composed of:

- Force transducer (load cell)
- Position transducer (incremental encoder)
- Electronic system for the control, saving and printing of the pressing curve.

Dimensions:

Bulk and size = F 340 x G 390 x H 835 mm

Weight: 105 Kg.

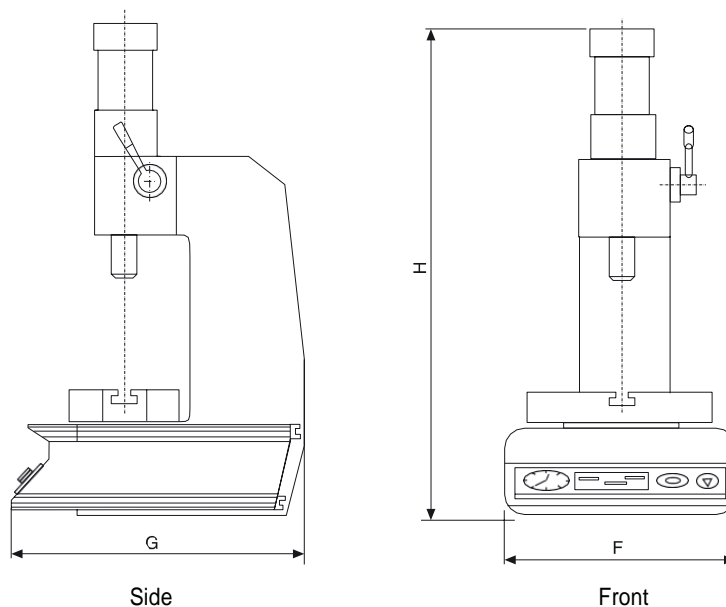


Figure 9

Side

Front

