Threaded unions
Design for HP MJF: Union joints design

Introduction

The most widely used types of joints are screws and threaded parts because they can be disassembled several times and create strong and durable joints. The use of threads in plastic parts is common in the design of caps and customized fasteners or to join tubes.

General recommendations

HP Multi Jet Fusion technology allows users to print external and internal threads inside the part, eliminating the need for mechanical thread-forming operations.

It is recommended to print external and internal threads in sizes larger than 6 mm (M6 or ¼ inch per the Imperial system) to achieve favorable results in all printing orientations. If a small thread (less than 6 mm) is needed, it is recommended to use self-tapping screws, threaded inserts, or to machine the thread for the small tolerances required in these sizes.

Tolerances are dependent upon the material, print mode, and post-processing selected. For this reason, it is recommended to first validate the design with different offsets before printing multiple parts.

Design guidelines

Self-tapping screws

Although HP Multi Jet Fusion technology allows for the printing of small features such as external and internal threads inside the part, when a small thread (up to 6 mm) is needed, it is recommended to use self-tapping screws, which tap their own threads as they are driven into the part. Certain types of self-tapping screws require a pre-formed hole, the dimensions of which can be recommended by the screw supplier.

Figure 1: Self-tapping screw

Machined threads

Another alternative when a small thread (up to 6 mm) is needed is to machine the part after printing it in order to achieve the required accuracy. The tools recommended for machining HP Multi Jet Fusion parts are the same as other technical plastics. Although not recommended, tools for machining metals like steel or aluminum may also be used.

A standard machining process can achieve dimensional tolerances up to ±0.05 mm.

Internal threads

To machine an internal thread, it is necessary to start from a pre-formed hole and then machine the thread using the required tap. To design the pre-hole on the printed part, designers can refer to usual drill size recommendations for plastic and metal. For example, drill size recommendations for metric plastic threads are shown in the following table:

1. ISO Standard metric threads

ISO Metric thread size	Drill size (mm)
M3	2,5
M4	3,3
M5	4,2
M6	5
M8	6,8
M10	8,5
M12	10,2
M16	14
M20	17,5
M24	21
M30	26,5
M36	32
M42	37,5
M48	43
M50	47
M56	50,5

2. ISO Fine metric threads

ISO Metric thread size	Drill size (mm)
M3 x 0,35	2,65
M4 x 0,5	3,5
M5 x 0,5	4,5
M6 x 0,75	5,2
M8 x 1	7
M10 x 1,25	8,8
M12 x 1,25	10,8
M16 x 1,5	15,4
M20 x 1,5	18,5
M24 x 2	22
M30 x 2	28
M36 x 3	33

3. Whitworth threads

Thread size (inches)	Drill size (mm)	
	BSW	BSP
1/16	1,2	--
3/32	1,8	--
1/8	2,6	8,9
5/32	3,1	--
3/16	3,6	--
7/32	4,4	--
1/4	5,1	11,9
5/16	6,5	--
3/8	7,9	15,4
1/2	10,5	19
5/8	13,5	--
3/4	16,5	24,7
7/8	19,3	28,4
1	22	30,8
1 1/8	24,8	35,5
1 1/4	27,8	39,4
1 3/8	30,5	42
1 1/2	33,5	45,4

Table 1: Drill size recommendations for plastic threads

Usually when machining metal parts, a set of three taps must be used to complete the process. With HP plastic materials, this can be reduced and only the final tap is needed due to the low hardness of HP material compared with the steel material of the tap.

Figure 2: HP MJF pre-formed hole testing

External threads

To machine an external thread, it is necessary to start from a solid printed cylinder and then machine the thread using the required die. The diameter of the cylinder to be machined must be slightly smaller than the die's major diameter. Typical cylinder diameter recommendations for plastic and metal are applicable.

Figure 3: Metric die

Standard printed threads

To ensure a satisfactory assembly operation with HP Multi Jet Fusion technology, there are a few recommendations when designing threads larger than 6 mm under international standards (e.g., DIN 13-1, ISO 965-2, ANSI/ASME B1.1). These international standards usually specify tolerances relative to diameter and pitch of a thread.

When designing internal threads, the less restrictive tolerance values (maximum tolerance values) should be used, and when designing external threads, more restrictive tolerance values (minimum tolerance values) should be used. For example, when designing metric threads under the ISO 965-2 standard—threads with general-purpose tolerances (6H-6g) and normal engagement length—the recommended design values are shown in the following table:

		Internal threads - 6H					External threads - 6g					
		ØD	Pitch Diameter Ø		Minor Diameter Ø		Major Diameter Ø		Pitch Diameter Ø		Minor Diameter Ø	
Thread	Pitch	min.	min.	max.	min.	max.	max.	min.	max.	min.	max.	min.
M8	1.25	8	7.188	7.348	6.647	6.912	7.972	7.760	7.160	7.042	6.438	6.272
M10	1.5	10	9.026	9.206	8.376	8.676	9.968	9.732	8.994	8.862	8.128	7.938
M12	1.75	12	10.863	11.063	10.106	10.441	11.966	11.701	10.829	10.679	9.819	9.602
M16	2	16	14.701	14.913	13.835	14.210	15.962	15.682	14.663	14.503	13.508	13.271
M20	2.5	20	18.376	18.600	17.294	17.744	19.958	19.623	18.334	18.164	16.891	16.625

Table 2: Recommended external and internal thread tolerances for HP MJF, based on ISO 965-2 tolerances

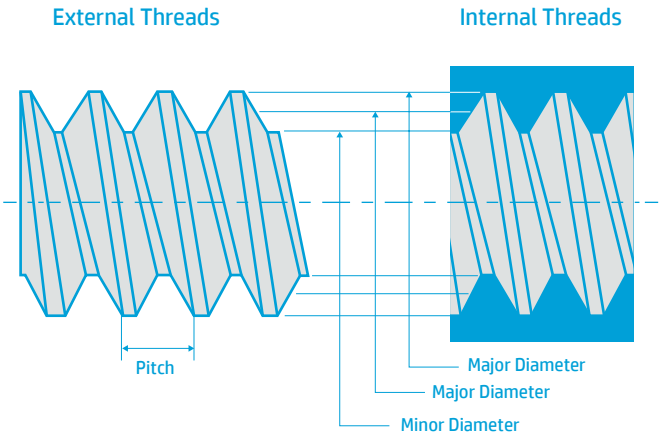

Figure 4: Features of external and internal threads

Customized threads

For customized threads, all external and internal threads should be designed with a gap of 0.2 mm to 0.4 mm between the external and the internal thread, as appropriate.

It is recommended to remove all sharp edges and apply a minimum radius of 0.1 mm when designing threads for HP Multi Jet Fusion parts.

Figure 5: Round edges for custom-printed threads

Post-processing guidelines

Threads can be considered a very fine detail and should be cleaned using a manual or automatic sandblasting machine with glass bead particles that range from 70 to 110 microns in size and 3 to 4 bars in terms of pressure. For cases in which a vibratory finishing (tumbling) is required to improve surface roughness in other areas, it is recommended to first clean the threads using a sandblasting machine. Usually the media used in vibratory finishing are too big to clean the space between the threads.

It is more difficult to clean internal threads; for this reason, it is better to reduce the length of this type of thread and make through holes when possible. For internal and external threads, it is possible to use taps and dies if they are not completely cleaned or if there is excessive friction.

Painting the threads is not recommended in any case; parts can be painted only if they are already assembled.

For this reason, dying is the best option for coloring threaded parts without altering the dimensional accuracy.

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