



Dimensional tolerancing

Design for HP MJF: Union joints design

Introduction

HP Multi Jet Fusion technology allows for the designing and printing of parts that can be assembled between them or to other manufactured parts, such as metal parts, to create final products and functional assemblies. The parts can be joined by union joints such as self-tapping screws, threaded inserts, or snap-fits.

It is important to consider tolerances at an early stage of the product development process and to design every part involved in a final product or functional assembly taking into account the permissible range of variation in dimensions to ensure that it fits suitably and works according to the design intent.

Depending on how the parts must interact to create a final product or achieve the assembly’s functional needs, the required tolerances will be tighter or wider, which will require the most capable manufacturing process to produce the part with suitable accuracy.

International Tolerance (IT) Grades

Designing a part often involves the use of the International Tolerance Grades defined in ISO 286, which provide a standardized reference for typical manufacturing process capability in terms of tolerance accuracy for a given dimension.

The most common manufacturing processes have an associated IT Grade that specifies their capability to provide accurate parts, as shown in the image below:

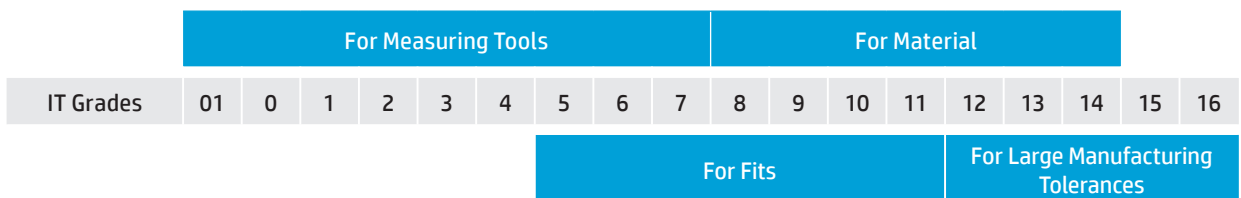


Figure 1: International Tolerance (IT) Grades

Each IT Grade establishes the allowable tolerance limits for a given dimension. As shown in the following table, a smaller IT Grade provides tighter tolerances:

Standard tolerance grades	Values of standard tolerance (mm)								Nominal size (mm)
	from: 1 to: 3	3 to 6	6 to 10	10 to 18	18 to 30	30 to 50	50 to 80	80 to 120	
1	0,0015	0,0015	0,0015	0,0015	0,0015	0,002	0,002	0,003	Measuring tools
2	0,002	0,002	0,002	0,002	0,002	0,003	0,003	0,004	
3	0,003	0,003	0,003	0,003	0,004	0,004	0,005	0,006	
4	0,004	0,004	0,004	0,005	0,006	0,007	0,008	0,010	
5	0,005	0,005	0,006	0,008	0,009	0,011	0,013	0,015	Engineering fits, bearings, machining processes (grinding, turning)
6	0,007	0,008	0,009	0,011	0,013	0,016	0,019	0,022	
7	0,009	0,012	0,015	0,018	0,021	0,025	0,030	0,035	
8	0,014	0,018	0,022	0,027	0,033	0,039	0,046	0,054	
9	0,025	0,030	0,036	0,043	0,052	0,062	0,074	0,087	
10	0,040	0,048	0,058	0,070	0,084	0,100	0,120	0,140	
11	0,060	0,075	0,090	0,110	0,130	0,160	0,190	0,220	Large manufacturing, die casting, stamping, sand casting
12	0,090	0,120	0,150	0,180	0,210	0,250	0,300	0,350	
13	0,140	0,180	0,220	0,270	0,330	0,390	0,460	0,540	
14	0,250	0,300	0,360	0,430	0,520	0,620	0,740	0,870	
15	0,400	0,480	0,580	0,700	0,840	1,000	1,200	1,400	
16	0,600	0,750	0,900	1,100	1,300	1,600	1,900	2,200	
17	0,900	1,200	1,500	1,800	2,100	2,500	3,000	3,500	
18	1,400	1,800	2,200	2,700	3,300	3,900	4,600	5,400	

Table 1: Standard tolerance grades

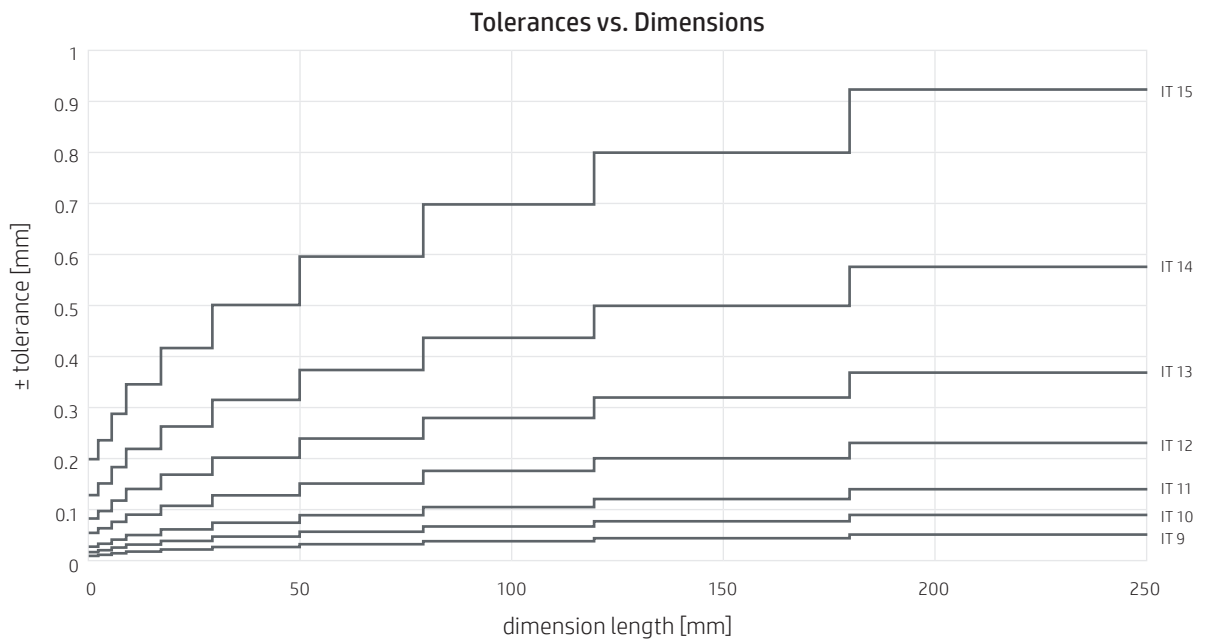


Figure 2: Graph of International Tolerance (IT) Grades

General plastic Injection Molding is typically capable of tolerances equivalent to an IT grade between 12 and 15. Precision plastic Injection Molding requires more costly detailed mold refinement, but is capable of tolerances equivalent to IT grades between 8 and 11.

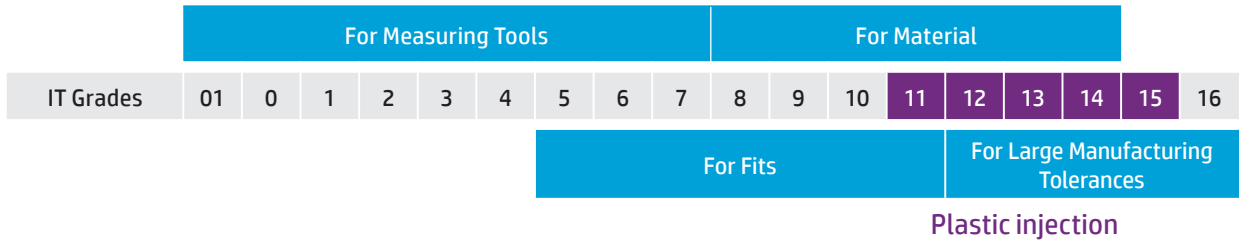


Figure 3: Plastic injection-equivalent IT Grades

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When designing parts with HP Multi Jet Fusion technology, it is possible to achieve accuracy values of IT Grade 13, with Cpk values that compete with plastic Injection Molding

According to the International Tolerance Grades defined in ISO 286, this range of variation in dimensions is equivalent to an IT Grade of 13.

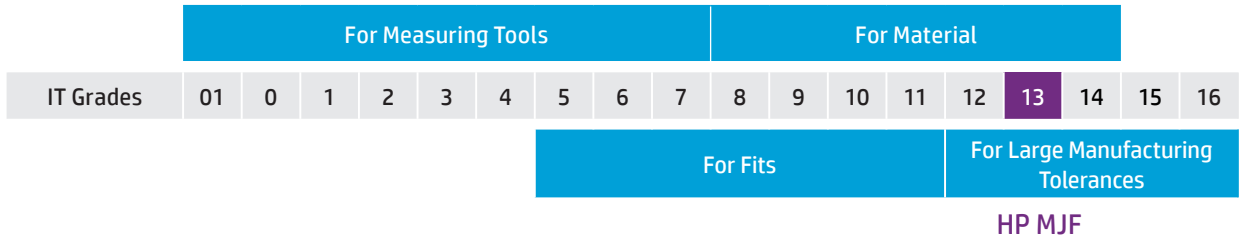


Figure 4: HP MJF-equivalent IT Grade

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