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Composite Positional Tolerancing[1]

When locating patterns of features, there are situations where the relationship from feature-to-feature must be kept to a certain tight tolerance and the relationship between the pattern and its datum features is not as critical and may be held to a looser tolerance. These situations often occur when technologies are combined that are typically held to different tolerances. For example, composite tolerancing is recommended where a hole pattern on a sheet metal part must be held to a tight tolerance from feature-to-feature and located with a looser tolerance from datum features that may has several bends between the datum features and the pattern.

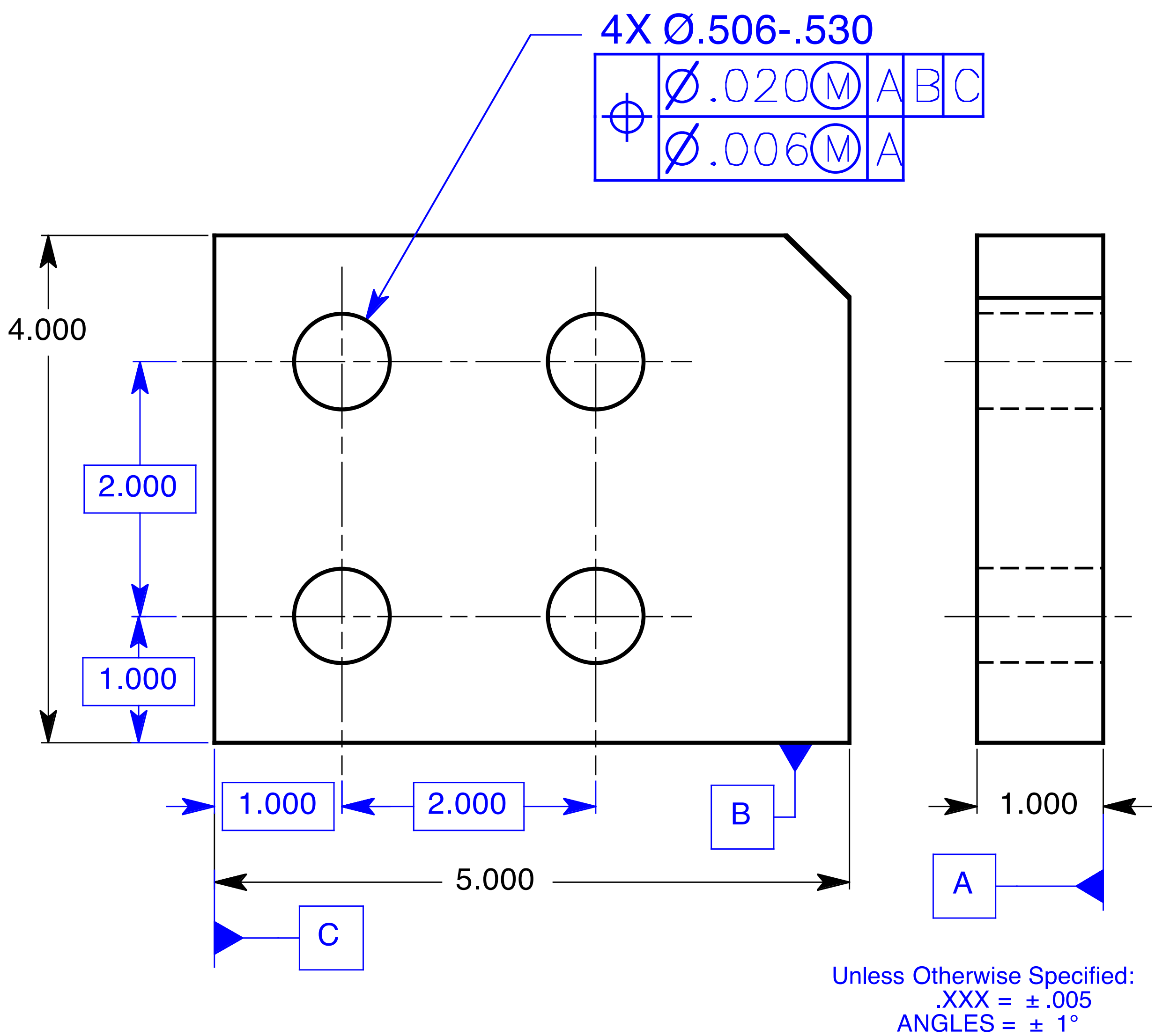

Figure 8-13 A composite positional tolerance controlling a four-hole pattern to its datum features with one tolerance and a feature-to-feature relationship with a smaller tolerance.

Another example is where a machined component is mounted to a welded frame, the location of the component may be able to float within a tolerance of 1/8 of an inch to the welded frame, but the mounting hole pattern may require a .030 tolerance from feature to feature. Both the sheet metal and the welded frame tolerancing examples can easily be achieved with composite positional tolerancing (Fig. 8-13).

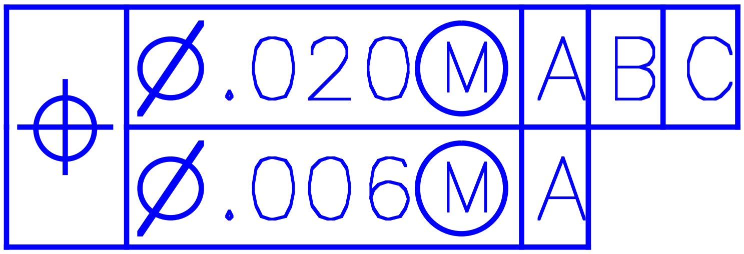

Figure 8-14 The composite feature control frame.

A composite feature control frame (Fig. 8-14) has one position symbol that applies to the two horizontal segments that follow. The upper segment is the pattern-locating control. It acts like any other position control. The pattern-locating control establishes the *pattern-locating tolerance zone framework* (PLTZF; this acronym is pronounced "plahtz"). The PLTZF governs the relationship between the datum features and the pattern. Letter A in the upper segment of the feature control frame in Figure 8-13 orients the Ø.020 cylindrical tolerance zones perpendicular to datum feature A. Letters B and C locate the tolerance zones with basic dimensions to datum features B and C.

The lower segment is referred to as the *feature-relating control*. It is a refinement of the upper control and governs the relationship from feature-to-feature. Each complete horizontal segment in the composite feature control frame must be verified separately, but the lower segment is always a subset of the upper segment. The feature-relating control establishes the *feature-relating tolerance zone framework* (FRTZF; this acronym is pronounced "fritz"). The FRTZF governs the relationship between features. The primary function of the position control is the location of features of size. In Fig. 8-13, the FRTZF controls the location of the Ø.006 cylindrical tolerance zones with basic dimensions to each other. The FRTZF is free to rotate and translate within the boundaries established and governed by the PLTZF. That is, the axis of each feature must fall inside each of its respective tolerance zones. In addition to controlling the tolerance zone location from feature to feature, the FRTZF controls the tolerance zones perpendicular to datum feature A within the tighter tolerance.

Datum features in the **lower segment** of a composite feature control frame must satisfy two conditions:

- Datum features in the lower segment must repeat the datum features in the upper segment of the feature control frame. If only one datum feature is repeated, it would be the primary datum feature; if two datum features were repeated, they would be the primary and secondary datum features; etc.

- Datum features in the lower segment only control orientation.

Figure 8-15 shows the graphic analysis approach to specifying composite tolerancing. The four-Ø.020 cylindrical tolerance zones are centered on their true positions located a basic 1.000-inch and a basic 3.000 inches from datum features B and C. These tolerance zones are locked in place.

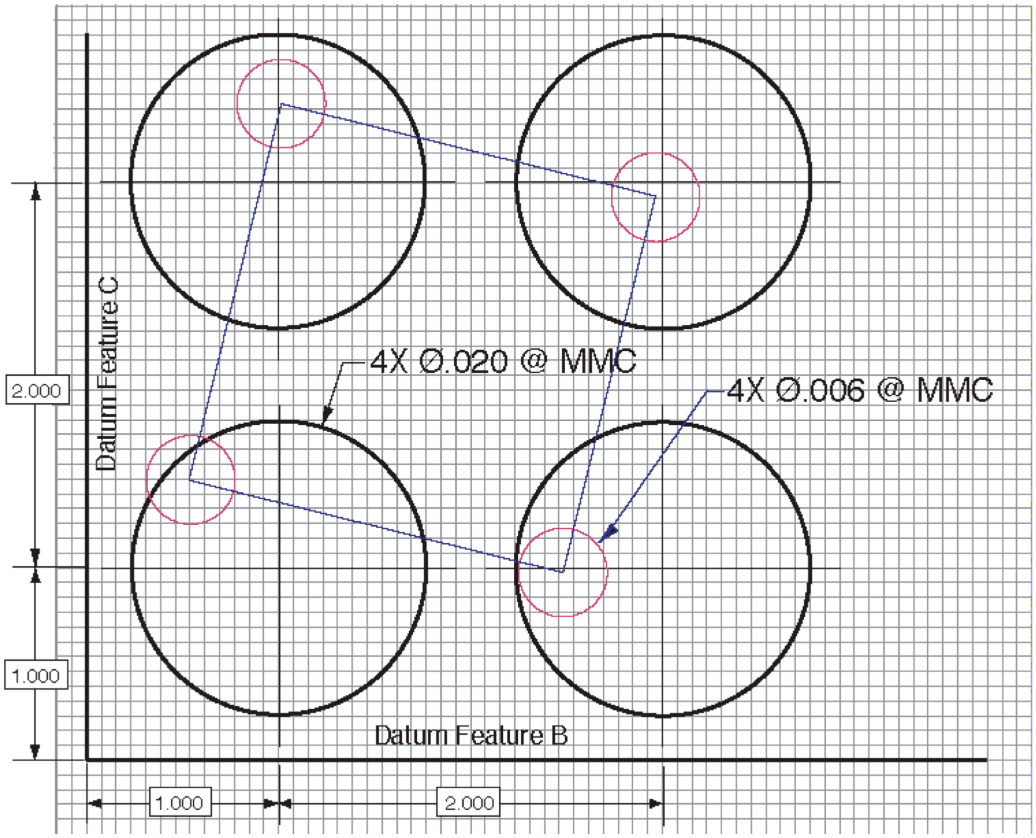

Figure 8-15 The datum-to-pattern and feature-to-feature tolerance zone relationship for Fig. 8-13.

The four-Ø.006 cylindrical tolerance zones are located a basic 2.000 inches from each other and are perpendicular to datum feature A. These four cylindrical tolerance zones are locked together in the feature-relating tolerance zone framework. The FRTZF can translate and rotate within the boundaries established by the PLTZF, but must remain perpendicular to datum feature A. Portions of the smaller tolerance zones may fall outside their respective larger tolerance zones, but those portions are unusable. In other words, in order to satisfy the requirements specified by the composite feature control frame, the entire feature axis must fall inside both its respective tolerance zones.

A second datum feature may be repeated in the lower segment of the feature control frame, as shown in Fig. 8-16. The second datum feature can only be datum feature B, and both datum features control only the orientation of the FRTZF. Since datum feature A in the upper segment only controls orientation, that is, perpendicularity, it is not surprising that datum feature A in the lower segment is a refinement of perpendicularity to the tighter tolerance. Where datum feature B is included in the lower segment of the composite feature control frame, the Ø.006 cylindrical tolerance zone framework must remain parallel to datum feature B. This means that the FRTZF is allowed to translate up and down and left and right but may not rotate about an axis perpendicular to datum feature A. The tolerance-zone framework must remain parallel to datum plane B at all times, as shown in Fig. 8-17.

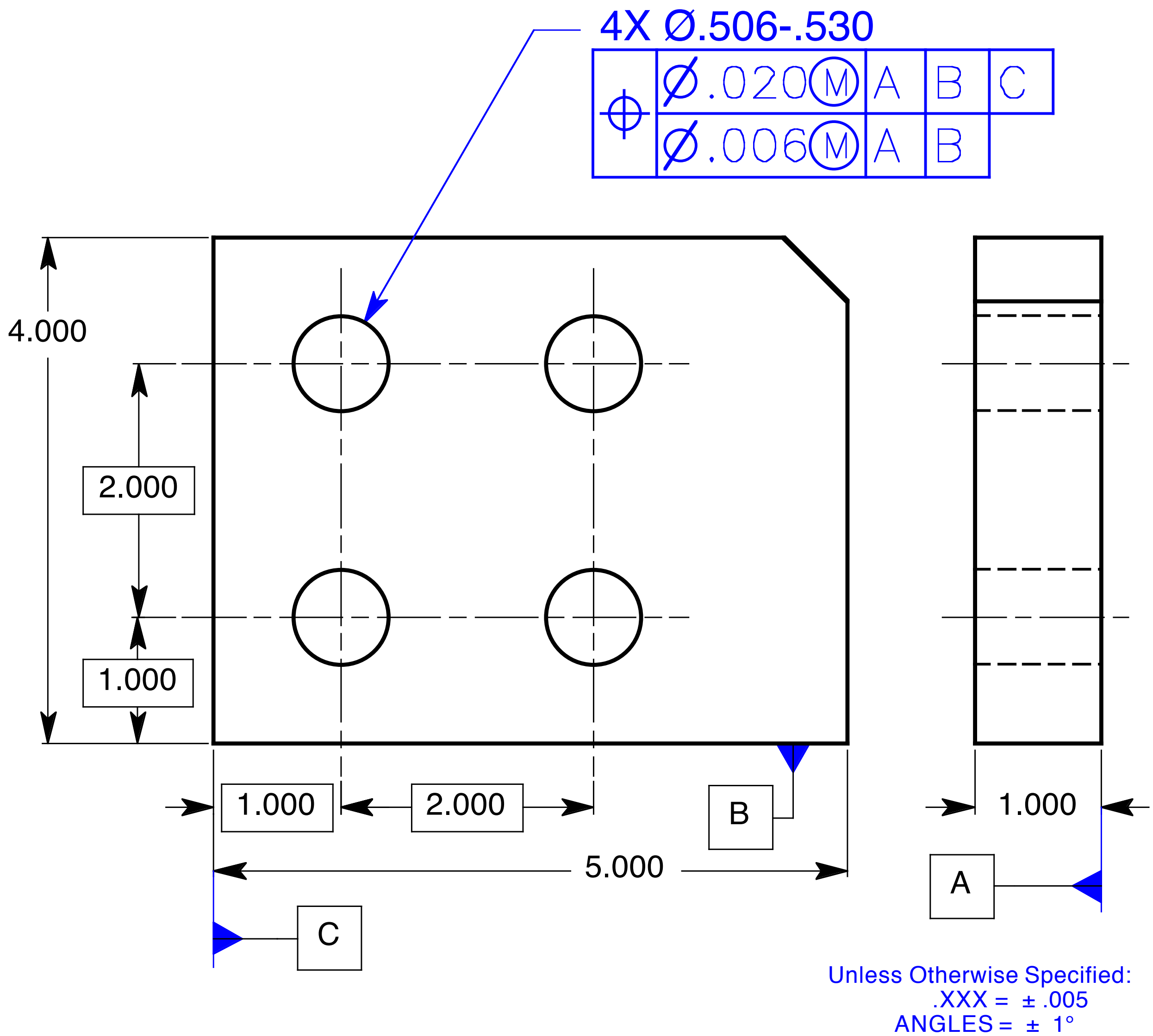

Figure 8-16 A composite positional tolerance with datum features A and B repeated in the lower segment of the feature control frame.

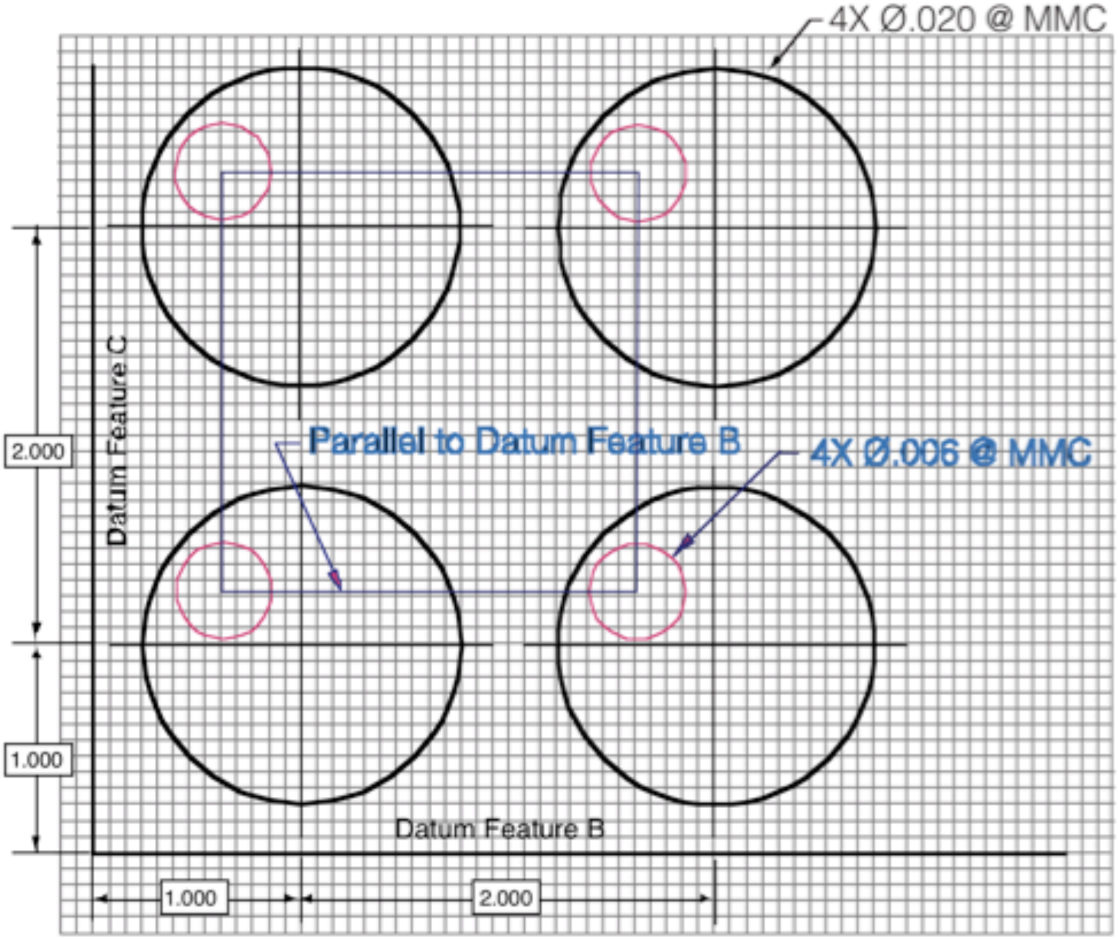

Figure 8-17 The datum to pattern and feature-to-feature tolerance zone relationships for the drawing in Fig. 8-16.

[1]Cogorno, Gene R., ***Geometric Dimensioning and Tolerancing for Mechanical Design, Second Edition***, McGraw-Hill, New York, 2011, p. 142