Part Size and Part Rotation in Carrier Tape

A Guide for Understanding the Relationship

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Engineering Department
13873 Park Center Road, Suite 315
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Understanding the rotational limits of part control related to part to pocket clearance

As parts get smaller and smaller, it becomes much more difficult to minimize the part rotation due to the higher percentage the tolerance makes up of both the part size and pocket size. Even a part with ±0.02mm tolerance and a pocket with ±0.03mm tolerance will have a minimum part to maximum pocket clearance of 0.10mm.

Part fit for rectangular devices is based on the corners hitting the side wall, and can be computed using the diagonal length of the part relative to the length and width of the pocket. See Figures 1-4

The device rotation is generally constrained by the walls of the longest edge of the pocket and device if the clearances are the same. The calculations are based on the following definitions

A is device length in x direction
B is device length in y direction
A_O is pocket size in x direction
B_O is pocket size in y direction
D is the length of the diagonal from corner to corner on the device
θ_1 is the standard angle of the device when sitting square to the pocket.
θ_{2A} and θ_{2B} are the angles of the device constrained by the pocket, calculated using both A_O and B_O direction constraints
θ is the maximum angle that the device moves from its standard position= θ_1- θ_2

The calculations are as follows:

$$D=\sqrt{A^2+B^2}$$

$$\theta_1 = \tan^{-1}(B/A)$$

$$\theta_{2A} = \theta_1 - (\cos^{-1}\frac{A_O}{D})$$

$$\theta_{2B} = (\sin^{-1}\frac{B_O}{D}) - \theta_1$$

Maximum Rotation θ = Min (θ_{2A}, θ_{2B})

The part diagonal length D=square root of ($A^2 + B^2$)

When centered in the tape, the standard angle of the diagonal is $\tan^{-1}(B/A) = \theta_1$ as shown in Figure 4

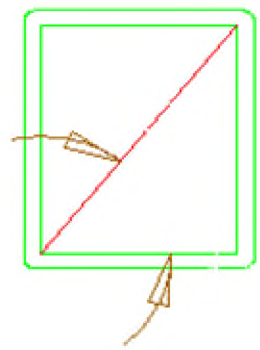
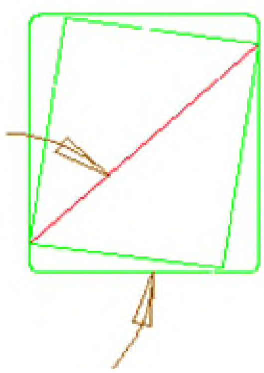


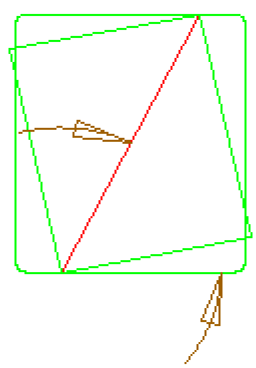
Figure 1

When rotated so that the corners are constrained by the longest wall, the new angle θ_2 can be computed because we know the diagonal distance D and we now know the constrained distance A_o

$\theta_2 = [\theta_1 - \cos^{-1}(A_o/D)]$ or $[\sin^{-1}(B_o/D) - \theta_1]$ depending on the constraining wall as shown in Figure 2 and 3.

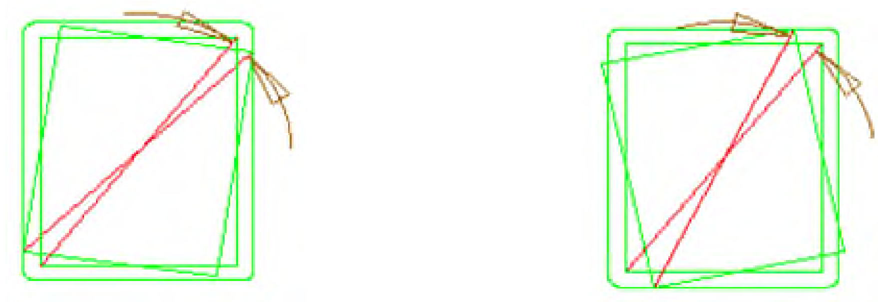


Rotated Angle A_o Contained



Rotated Angle B_o Contained

Figure 2



Device Rotation A₀ Contained **Device Rotation B₀ Contained**

Figure 3

θ is the minimum of θ_{2A} and θ_{2B} and represents the maximum rotation angle that the device can move. By using maximum pocket dimensions and minimum device dimensions, we can determine the maximum rotation of the device in the pocket as shown in Figure 4.

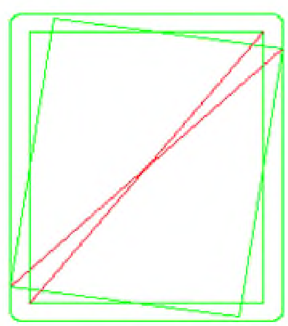


Figure 4

An example is shown below in Figure 5 and Table 1 using a minimum pocket size of A_o = 20 min, B_o = 25 min, and maximum device size of A=17° max, and B =22° max.

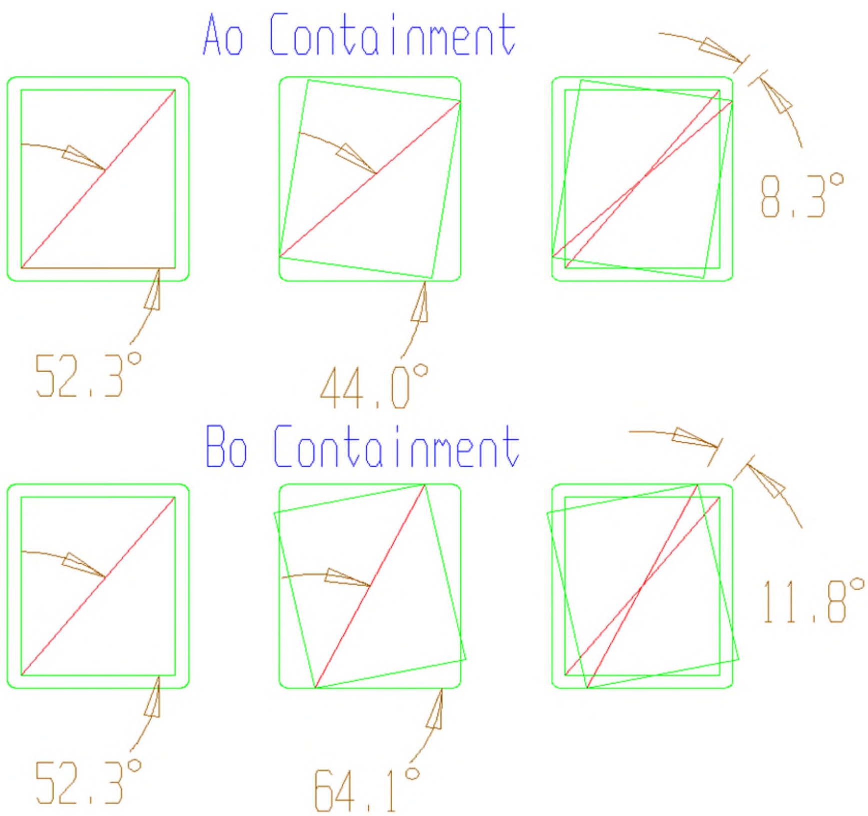


Figure 5

Table 1

	Inputs (mm)	Computations (degrees)	
A Max	17		
B Max	22		
A_o Min	20		
B_o Min	25		
		Angle	Difference
D		27.8	
θ_1		52.3	
θ_{2A}		44.0	8.3
θ_{2B}		64.1	11.8
θ (Min of θ_{2A} and θ_{2B})		8.3	