



## *Application Information*

# *RF Tag Capture Window Calculation*

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**Objectives** The purpose of this application note is to give customers, system integrators, and sales personnel a method of approximating the size of the tag capture window for the radio frequency identification products.

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**Overview** The capture window is the area in front of an antenna that provides enough RF energy to successfully read or write to a tag. This application note gives a formula for obtaining the **approximate** size of the capture window. The actual capture window size is application dependent. Actual capture window size is obtained by plotting the antennas' RF emission pattern for each antenna while taking into account the metal surroundings of each antennas' location.

The information presented here will give the users of Allen-Bradley RF products a capture window size approximation close enough to determine the necessary object detect timing and placement for their unique RF application.

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**Related Publications** Several Allen-Bradley products are referred to in this application note. If you require more detailed information on these products, refer to the publications listed below.

Table A  
Related Publications

Title	Publication No.
2750-AS, -ASP, -ASD Users Manual	2750-807
2750-AU, -AUP, -AUD Users Manual	2750-804

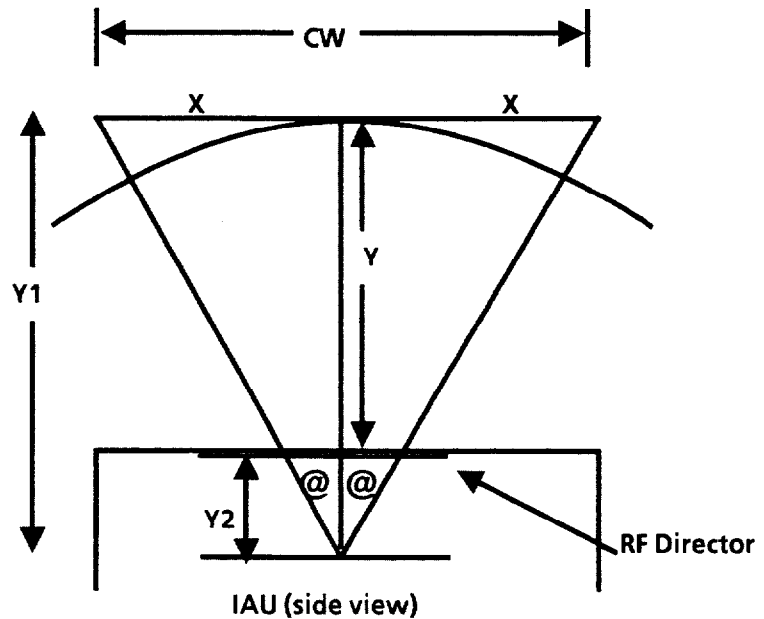
**Antenna Type**

The capture window calculations presented in this application note are appropriate for all Allen-Bradley 915 MHz antennas. See Table A for the users manual publication numbers for these antennas.

**Calculating RF Capture Window Size**

In Diagram 1, Y2 takes into account the fact that the antennas' RF transmission source is 1.75 inches below the front surface of the antennas' case. Table B defines the terms used in Diagram 1.

**Diagram 1**  
**Capture Window Diagram Approximation in Free Space**



**Table B**  
**Definition of the Terms in Diagram 1**

Term	Definition
Y	Customer's maximum tag reading distance
Y2	Distance from antenna surface to RF transmission source (Y2 = 1.75")
Y1	Customer reading distance plus distance to RF transmission source (Y1 = Y2 + Y)
X	One-half the capture window
@	One-half the RF emission angle (@ = 25°)
CW	RF tag capture window

RF TAG CAPTURE WINDOW FORMULA  
 $CW = 2( \text{TAN } @^\circ \times Y1 )$

## Capture Window Calculations

The following examples demonstrate how to compute the capture window size for RF tag readings at varying distances.

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**Example #1** Calculate the RF capture window for a tag reading distance of 48 inches.

**Step 1** Find Y1

$$\begin{aligned} Y1 &= Y2 + Y \\ &= 1.75'' + 48'' \\ &= 49.75'' \end{aligned}$$

**Step 2** Tan @ = Tan 25°  
= .4663

**Step 3** Find Capture Window (CW)

$$\begin{aligned} CW &= 2(\tan 25 \times 49.75'') \\ &= 2( .4663 \times 49.75'') \\ &= 2( 23.2'') \\ CW &= 46.4'' \text{ for a 48'' tag reading distance} \end{aligned}$$

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**Example #2** Calculate the RF capture window for a tag reading distance of 30 inches.

**Step 1** Find Y1

$$\begin{aligned} Y1 &= Y2 + Y \\ &= 1.75'' + 30'' \\ &= 31.75'' \end{aligned}$$

**Step 2** Tan @ = Tan 25°  
= .4663

**Step 3** Find Capture Window (CW)

$$\begin{aligned} CW &= 2(\tan 25 \times 31.75'') \\ &= 2( .4663 \times 31.75'') \\ &= 2( 14.8'') \\ CW &= 29.6'' \text{ for a 30'' tag reading distance} \end{aligned}$$



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**Example #3** Calculate the RF capture window for a tag reading distance of 24 inches.

**Step 1** Find Y1

$$\begin{aligned} Y1 &= Y2 + Y \\ &= 1.75" + 24" \\ &= 25.75" \end{aligned}$$

**Step 2**  $\tan @ = \tan 25^\circ$   
= .4663

**Step 3** Find Capture Window (CW)

$$\begin{aligned} CW &= 2(\tan 25 \times 25.75") \\ &= 2(.4663 \times 25.75") \\ &= 2(12") \\ CW &= 24" \text{ for a 24" tag reading distance} \end{aligned}$$


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**Example #4** Calculate the RF capture window for a tag reading distance of 8 inches.

**Step 1** Find Y1

$$\begin{aligned} Y1 &= Y2 + Y \\ &= 1.75" + 8" \\ &= 9.75" \end{aligned}$$

**Step 2**  $\tan @ = \tan 25^\circ$   
= .4663

**Step 3** Find Capture Window (CW)

$$\begin{aligned} CW &= 2(\tan 25 \times 9.75") \\ &= 2(.4663 \times 9.75") \\ &= 2(4.55") \\ CW &= 9.1" \text{ for an 8" tag reading distance} \end{aligned}$$


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**Example #5** Calculate the RF capture window for a tag reading distance of 5 inches.

**Step 1** Find Y1

$$\begin{aligned} Y1 &= Y2 + Y \\ &= 1.75" + 5" \\ &= 6.75" \end{aligned}$$

**Step 2**  $\tan @ = \tan 25^\circ$   
= .4663

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**Example #5**    **Step 3**    Find Capture Window (CW)  
(continued)

$$\begin{aligned} \text{CW} &= 2(\tan 25^\circ \times 6.75") \\ &= 2(.4663 \times 6.75") \\ &= 2(3.14") \\ \text{CW} &= 6.3" \text{ for a } 5" \text{ tag reading distance} \end{aligned}$$

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**Example #6**    Calculate the RF capture window for a tag reading distance of 2 inches.

**Step 1**    Find Y1

$$\begin{aligned} \text{Y1} &= \text{Y2} + \text{Y} \\ &= 1.75" + 2" \\ &= 3.75" \end{aligned}$$

**Step 2**    Tan @    =    Tan 25°

$$= .4663$$

**Step 3**    Find Capture Window (CW)

$$\begin{aligned} \text{CW} &= 2(\tan 25^\circ \times 3.75") \\ &= 2(.4663 \times 3.75") \\ &= 2(1.75") \\ \text{CW} &= 3.5" \text{ for a } 2" \text{ tag reading distance} \end{aligned}$$

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**Summary**    Use of the aforementioned formulas and procedures, will provide the RFID user with an approximation of RF capture window size as a function of the tags' reading distance. Actual capture window size depends on the application environment.