How to Calculate a Wire Bundle Diameter that Matches the Aperture Size of a Ground Fault Sensor

CONDUCTORS UP TO 0.75" DIAMETER

CONDUCTORS UP TO 1.31" DIAMETER

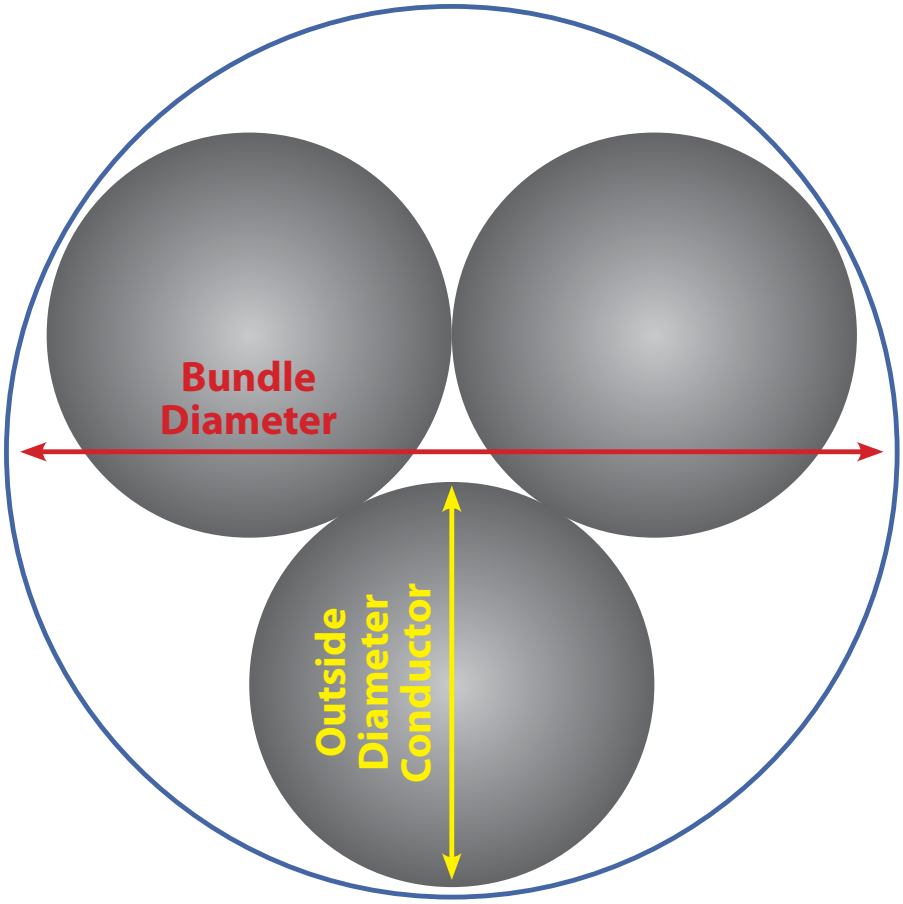
CONDUCTORS UP TO 1.82" DIAMETER

CONDUCTORS UP TO 4.00" DIAMETER

Introduction: How to determine whether ground fault sensor's aperture window diameter will be the right size for your bundle of wires. Using only a few key pieces of information: wire diameter and number of identical diameter conductors to pass through the NK Technologies ground fault sensor.

Note: If all conductor diameters are not identical, then contact NK Technologies technical services at ***techsupport@nktechnologies.com*** or (800) 959-4014 ext. Services available from 7:30 am – 5:00 pm PST.

Scope: Calculation of diameter of outer circle to which multiple number of identical inner circles can be inserted. References Kravitz table and Friedman's formulas



Overall wire bundle diameter is calculated using the following equation:

D_{BUNDLE}= CF*D_{MAX}

Where D_{BUNDLE} is diameter of bundle of conductors, D_{WIRE} is outside diameter of actual conductor, 'CF" is correction factor

Procedure

Equation 1: D_{BUNDLE}= CF*D_{MAX}

1) Locate manufacture's maximum outside diameter of the conductor **(D_{MAX})**. If conductor sizes are insignificantly different in size, then use largest outside diameter to achieve best results.

   Calculate Maximum Diameter Conductor using equation 2

   Equation 2: D_{MAX} = D_{WIRE} x (1+ 'Installation Margin')

   a) Installation Margin: add tolerance to ease assembly during installation, adding 3 % to 5 % is recommended.

   b) If unable to locate diameter of the conductor from manufacture, a table is provided for most widely used conductor type. Refer to Table 1

2) Lookup correction factor (**CF**) using Table 2, where **CF** is dependent on number of conductors to be routed through NK Technologies ground fault sensor

3) Calculate wire bundle diameter (**D_{BUNDLE}**) = using equation 1, above.

4) Using calculated wire bundle diameter (**D_{BUNDLE}**) select aperture window diameter of ***NK Technologies ground fault sensors***, Select aperture widow diameter greater than the calculated wire bundle diameter (**D_{BUNDLE}**).

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Example:

3 Phase branch circuit; 208V, 50A, 3 Phase Delta load, aka '3 + 1' or '4 wire'

1) D_{MAX} = 0.265 x (1 + 0.05)= is **0.278 inch**,
   a. THHN wire (6-01THHN), per Table 1 nominal final diameter (D_{WIRE}) is 0.265 inch
   b. Assembly margin= 5%
2) **CF= 2.155**
   a. Three (3) conductors will pass through the ground fault sensor aperture
3) D_{BUNDLE} = 2.155 x 0.278= **0.600 inch**
4) AG Series is best fit for the application.

   a. Conductors Up To 0.75" Diameter
   b. Where 0.571 inch (D_{BUNDLE}) < 0.75 inch (AG Series aperture diameter)

Commercial Kitchens

Pump Monitoring

Semiconductor Fabrication

Table 1, THNN Conductor Diameter, reference USA Wire & Cable, Inc.

USAWC Part #	Size AWG or kcmil	No. of Strands	Thickness in Mils		Nom-final Diam. Inches
			PVC Insula-tion	Nylon Jacket	
Solid (THWN or THHN)					
14-01SOLTHHN	14	Solid	15	4	.105
12-01SOLTHHN	12	Solid	15	4	.122
10-01SOLTHHN	10	Solid	20	4	.153
Stranded (MTW or THWN or THHN)					
14-01THHN	14	19	15	4	.112
12-01THHN	12	19	15	4	.130
10-01THHN	10	19	20	4	.164
8-01THHN	8	19	30	5	.220
6-01THHN	6	19	30	5	.256
4-01THHN	4	19	40	6	.325
3-01THHN	3	19	40	6	.353
2-01THHN	2	19	40	6	.386
1-01THHN	1	19	50	7	.443
1/0-01THHN	1/0	19	50	7	.484
2/0-01THHN	2/0	19	50	7	.529
3/0-01THHN	3/0	19	50	7	.579
4/0-01THHN	4/0	19	50	7	.635
250-01THHN	250	37	60	8	.703
300-01THHN	300	37	60	8	.756
350-01THHN	350	37	60	8	.806
400-01THHN	400	37	60	8	.851
500-01THHN	500	37	60	8	.934
600-01THHN	600	61	70	9	1.03
750-01THHN	750	61	70	9	1.14
1000-01THHN	1000	61	70	9	1.32

Note: Manufacturer could update this table without notice, leading to potential no fit condition.

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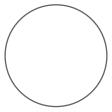
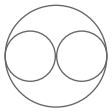
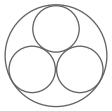
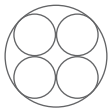
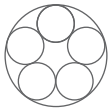
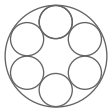
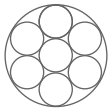
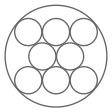
Table 2, Correction Factor based on Kravitz's table and Friedman's formula

Number of Wires in Bundle	Correction Factor (CF)	Illustration
1	1.000	
2	2.000	
3	2.155	
4	2.414	
5	2.701	
6	3.000	
7	3.000	
8	3.646	
9	3.800	
10	4.000	

References

Friendman, E. "Circles in Circles" ***http://www.stetson.edu/~efriedma/cirincir/***

Kravitz, S. "Packing Cylinders into Cylindrical Containers", Math. Mag 44, 65-70, 1967

THNN wire specification; USA Wire & Cable, page 2, Nom Final Diam. Inches