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NEMA STANDARDS PUBLICATION

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OCCUPANCY MOTION SENSORS

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

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Occupancy Motion Sensors

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Foreword

The purpose of this guide is to promote uniformity for the definition and measurement of characteristics relevant to the use and application of occupancy motion sensors. The guide is not intended to set performance levels.

In the preparation of this guide publication, input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the NEMA Wiring Device Section by contacting the:

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This is the first edition of the guide.

The standards or guidelines presented in a NEMA standards publication are considered technically sound at the time they are approved for publication. They are not a substitute for a product seller's or user's own judgment with respect to the particular product referenced in the standard or guideline, and NEMA does not undertake to guarantee the performance of any individual manufacturer's products by virtue of this standard or guide. Thus, NEMA expressly disclaims any responsibility for damages arising from the use, application, or reliance by others on the information contained in these standards or guidelines.

This guide was developed by the NEMA Wiring Device Section. Section approval of the guide does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the NEMA Wiring Device Section was composed of the following members:

AMP Incorporated—Harrisburg, PA
Lutron Electronics Company, Inc.—Coopersburg, PA
Watt Stopper, Inc.—Santa Clara, CA
Arrow-Hart Wiring Devices—Syracuse, NY
Marinco/Marine Industries Company—Napa, CA
Wiremold Company—West Hartford, CT
Bryant Electric, Inc.—Milford, CT
McGill Electrical Product Group—Valparaiso, IN
Daniel Woodhead Company—Northbrook, IL
MYTECH Corporation—Austin, TX
Eagle Electric Manufacturing Co., Inc.—Long Island City, NY
Novitas, Inc.—Culver City, CA
Ericson Manufacturing Company—Willoughby, OH
Panel Components—Oskloosa, IA
GE Wiring Devices—Cleveland, OH
Pass & Seymour/Legrand—Syracuse, NY
Genlyte Thomas Group LLC—Garland, TX
Steel City—Memphis, TN
Hubbell Incorporated—Bridgeport, CT
Technology Research Corporation—Clearwater, FL
Leviton Manufacturing Co., Inc.—Little Neck, NY
UNENCO Electronics—Milford, CT

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Section 1
GENERAL

1.1 SCOPE

This guide publication covers the definition and measurement of characteristics relevant to the use and application of occupancy motion sensors of passive infrared and ultrasonic types. These sensors are used in systems for control of lighting, heating, ventilating, and air conditioning (HVAC), and other devices.

1.2 REFERENCES

The following publications are adopted in part, by reference in this publication, and are available from the organizations below.

1.2.1 Normative References

The following normative documents contain provisions, which through reference in this text, constitute provisions of this standards publication. By reference herein these publications are adopted in whole or in part as indicated, in this guide publication.

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062

UL 773A *Nonindustrial Photoelectric Switches for Lighting Control, Fourth Edition (1995)*

International Electrotechnical Commission (IEC)
3. rue de Varembé, P.O. Box 131
1211 Geneva 20, Switzerland

IEC 61000-4-2 (1995) + amd. 1 (1998) *Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 2: Electrostatic Discharge Immunity Test*

IEC 61000-4-3 (1995) + amd. 1 (1998) *Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 3: Radiated, Radio-frequency, Electromagnetic Field Immunity Test*

IEC 61000-4-4 (1995) *Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 4: Electrical Fast Transient/burst Immunity Test*

IEC 61000-4-5 (1995) *Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques - Section 5: Surge Immunity Test*

1.3 DEFINITIONS

The definitions below apply to terms used in this guide publication or in manufacturers' specification sheets and product literature, or both. Where the terms are used in this guide publication or in a manufacturer's specification sheet or other product literature, the following definitions apply.

bypass: the means of forcing loads into "ON" or "OFF" condition by circumventing the device.

cell: a 3 feet by 3 feet section of the grid.

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coverage area: the area in which the sensor can detect motion, comprised of the horizontal and vertical fields of view.

energy consumption: total consumption in milliwatts for 1 hour with the controlled load "ON" for 30 minutes and "OFF" for 30 minutes.

grid: the area in which the sensor is tested divided into 3 feet by 3 feet sections.

horizontal field of view: the area of coverage in a horizontal plane to the sensor while the sensor is mounted in the orientation recommended by the manufacturer. The height of the horizontal field is at a level of 36 inches ± 1 inch above the ground.

immunity to false activation: the ability to ignore external events which are not intended to activate the product.

initial trigger motion detection: the condition when the sensor is operating in an unoccupied coverage area.

line of sight coverage: the ability to detect motion when there is not any object(s) between the motion and sensor to obscure or to block the detection of motion.

maintained motion detection: the condition when the sensor is operating in an occupied coverage area.

major motion: movement of a person walking into or through an area.

measurement units:
degrees for viewing angles
feet (m) for distance
feet and inches (m) for mounting height
feet per second (m/s) for velocity
square feet (m^2) for coverage area

minor motion: movement of a person sitting at an office desk reaching for a telephone, turning the pages in a book, opening a file folder, picking up a coffee cup, etc.

motion detection: a means to determine that the sensor has detected motion.

mounting height: the height above the floor to the center of the sensor.

override: the means of modifying the normal detection operation of the device to alter control functions.

passive infrared: type of occupancy sensor that uses thermal detectors to absorb the received energy focused on them. A change in energy received by a thermal detector results in a change in detector temperature, which results in an electrical signal. The more common thermal detector, the pyroelectric detector, has an output that is proportional to the rate of change of its temperature. Pyroelectric detectors respond to changes in received energy in the 7 to 14 micron portion of the electromagnetic spectrum. The detector aperture is converted optically, e.g., by a multi-segment, fresnel lens array, into multiple, discrete fields of view that are strategically located throughout the occupancy sensor pattern. When a person moves into or out of a field of view, the detector experiences a change in received energy, which is converted into an electrical signal.

sensitivity: the ability of the sensor to detect the designated magnitude of motion for a given application.

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time delay: the duration of time from the time the motion was last detected until the controlled loads are deactivated, e.g., lights turned off, signal given to other equipment, etc.

ultrasonic: type of occupancy motion sensor that emits a low power sound into the area being monitored. The sound wave is at a frequency above the range that a person can hear. Changes in the reflection pattern caused by motion are received by the sensor and converted into an electrical signal.

vertical field of view: the area of coverage in a vertical plane to the sensor while the sensor is mounted in the orientation recommended by the manufacturer.

volumetric coverage: the ability to detect motion that is generated behind an object that obstructs the line of sight between the motion and the sensor.

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Section 2
ILLUSTRATIONS

2.1 GENERAL

The horizontal or vertical fields of view may be illustrated in product literature, specifications, etc. The use of illustration is optional. If any illustration is used, it should meet the requirements below for minimum illustration and illustration format.

2.2 MINIMUM ILLUSTRATION

The illustration should include at least the following information:

a. Mounting height
b. Maximum horizontal coverage angle
c. Dimensions of coverage area
d. Dimensions of room (length, width, height)

The manufacturer should state whether the illustration is for initial trigger motion detection or for maintained motion detection.

2.3 FORMAT OF ILLUSTRATION

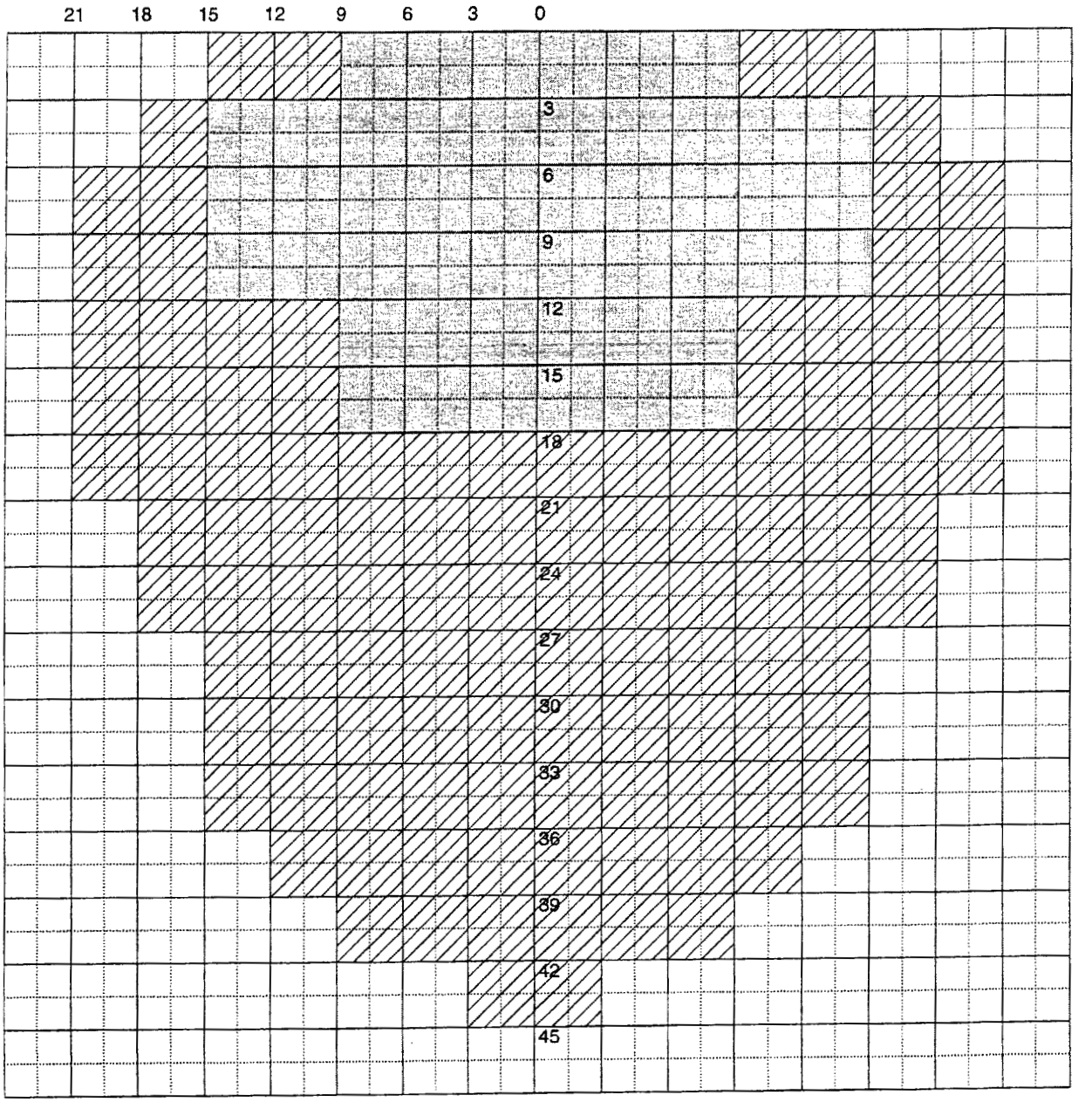
The illustration of the horizontal or vertical fields of view for passive infrared and ultrasonic devices should have the following format:

a. Grid pattern, with a maximum 3 feet by 3 feet cell size
b. Crosshatched cells where major motion is detected
c. Shaded or solid cells, where minor motion is detected

An example illustration is in Figure 2-1.

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Wall Switch PIR Pattern
(3 foot blocks)

Figure 2-1

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Section 3
TESTING

3.1 OPERATING CONDITIONS FOR COVERAGE AREA TESTING

3.1.1 Indoor Products

The coverage area testing for indoor products should be performed under the following conditions:

a. Temperature - 70 degrees F ± 3 degrees F
b. Humidity - 50 percent ± 10 percent

3.1.2 Outdoor Products

The coverage area testing for outdoor products should be performed under conditions specified in UL 773A.

3.2 MAJOR MOTION TESTING

The major motion test protocol is based on a conservative specified walk test that could be conducted by a central test facility.

3.2.1 Test Subject

Major motion should be tested using a person not more than 5 feet and 5 inches in height and 130 pounds in weight, wearing a short sleeve shirt and pants of a cotton-based material, shoes, and a professionally sized baseball cap worn backwards. The person should be moving at a velocity of 4 feet per second ± 0.5 foot per second.

3.2.2 Test Environment

The test should be conducted in an environment as described in the manufacturer's instructions for the normal installation of the product. There shall be no other people or moving objects in the coverage area.

3.2.3 Direction of Motion

Major motion is moving parallel to the x-axis and moving parallel to the y-axis as shown in Figure 3-1.

3.2.4 Setup and Test Procedure

a. Install the sensor to be tested in a room equal to or greater in size than the specified coverage area of the sensor. Wire in accordance with the manufacturer's instructions.

b. Prepare a template drawing for the test room showing the sensor location and divided into a square grid. The maximum size of each cell within the grid shall be 3 feet by 3 feet.

c. Allow the sensor to stabilize in accordance with the manufacturer's instructions.

d. If necessary, adjust the sensitivity of the sensor being tested in accordance with the manufacturer's instructions.

e. Ensure the temperature of the test room is maintained at 70 degrees F ± 3 degrees F throughout the test.

f. Ensure the humidity of the test room is maintained at 50 percent ±10 percent throughout the test.

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g. The test person should move in the direction parallel to the x-axis or parallel to the y-axis, or both, at the test velocity starting from a point outside the coverage area at the center of the outer edge of the first cell moving from cell to cell with a 2 second stop at the edge of each cell. If either of the movements parallel to the x-axis or parallel to the y-axis are detected by the sensor being tested, the test is positive for this cell. If the result is positive, crosshatch the cell on the template drawing. If the result is not positive, leave the cell open on the template drawing.

3.3 MINOR MOTION TESTING

3.3.1 Test Apparatus

Minor motion is tested using a robotic arm with dimensions 3 inches by 3 inches by 15 inches, mounted at a height of 36 inches ± 1 inch above the ground. The arm is moving at a velocity of 90 degrees per second.

3.3.2 Test Environment

The test should be conducted in an environment as described in the manufacturer's instructions for the normal installation of the product. The minor motion simulator should be started remotely, and there should be no other moving objects or people in the coverage area.

3.3.3 Direction of Motion

Minor motion is up to four 90 degree sweeps as described below and shown in Figure 3-2.

a. For the horizontal 90 degree sweep motion, the arm shall move in the x-y plane from 270 degrees to 0 degrees or from 90 degrees to 0 degrees, or both.

b. For the vertical 90 degree sweep motion, the arm should move in the x-z plane from 270 degrees to 0 degrees or from 90 degrees to 0 degrees, or both.

3.3.4 Setup and Test Procedure

a. Install the sensor to be tested in a room equal to or greater in size than the specified coverage area of the sensor. Wire in accordance with the manufacturer's instructions.

b. Prepare a template drawing for the test room showing the sensor location and divided into a square grid. The maximum size of each cell within the grid should be 3 feet by 3 feet.

c. Allow the sensor to stabilize in accordance with the manufacturer's instructions.

d. If necessary, adjust the sensitivity of the sensor being tested in accordance with the manufacturer's instructions.

e. Ensure the temperature of the test room is maintained at 70 degrees F ± 3 degrees F throughout the test.

f. Ensure the humidity of the test room is maintained at 50 percent ±10 percent throughout the test.

g. Setup the NEMA minor motion simulator on a movable platform and place it in the first cell. The simulator should be located in the center of the cell ± 2 inches off the x- and y-axis.

h. The temperature of the simulator must be 95 degrees F ± 2 degrees F. Allow the temperature to warm-up for a minimum of 1 hour prior to testing.

i. Start with the minor motion simulator to test motion in either the x-y plane or the x-z plane, or both.

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j. If any of the four 90 degree sweep motions are detected by the sensor being tested, the test is positive for this cell. If the test is positive, shade in the cell on the template drawing. If the result is not positive, leave the cell open on the template drawing.

k. Relocate the minor motion simulator to the center of the next grid area. Repeat steps i and j.

3.4 IMMUNITY TO ELECTRICAL AND ELECTRONIC EVENTS

For products manufactured for sale in some countries, the level of compliance with the following tests may need to be stated:

Standard	Test
IEC 61000-4-2	Electrostatic discharge immunity test
IEC 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4	Electrical fast transient/burst immunity test
IEC 61000-4-5	Surge immunity test

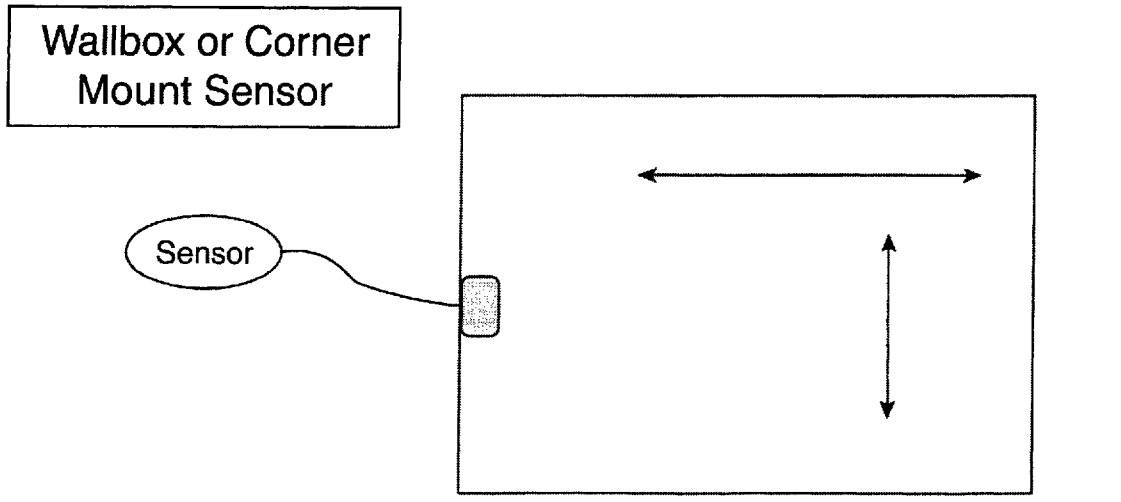
3.5 IMMUNITY TO CHANGES IN VISIBLE LIGHT OR ENERGY TESTING

Sensors should not trip when exposed to the following or its equivalent:

Illumination by a 60 watt halogen lamp through two planes of 4 mm glass separated by at least 10 mm, and arranged so that the lamp lies within a sensitive zone, should not be closer than 3,000 mm from the detector. It should be placed so as to produce an even flux of 6,500 lux ± 15 percent at the sensor cover, and the lamp should be rotated about a vertical axis to sweep the light 10 times across the detector at a (nominal) rate of 0.5 meters per second.

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Direction of Major Motion



Direction of motion is perpendicular to sensor face

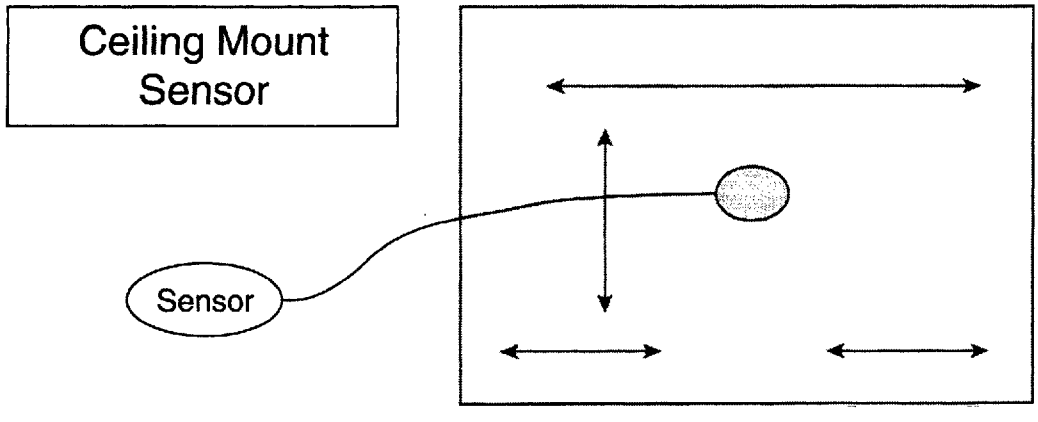


Figure 3-1

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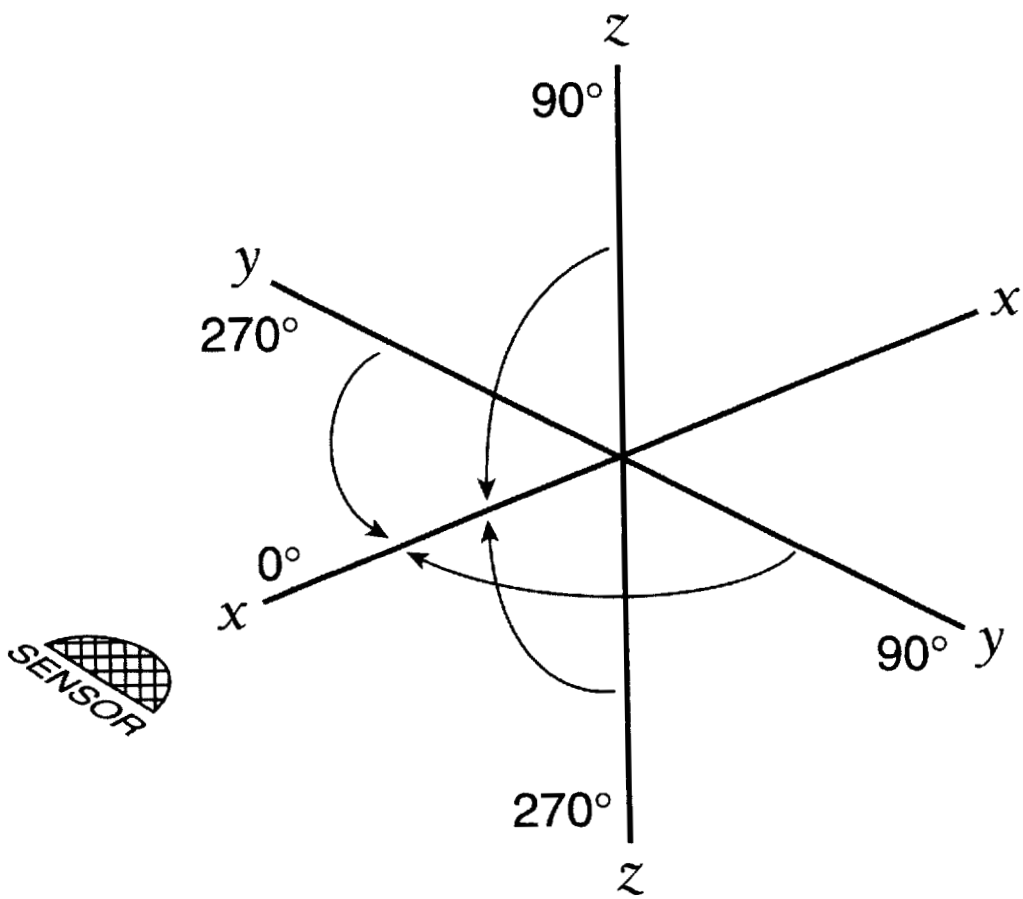


Figure 3-2

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