Matrix Codes

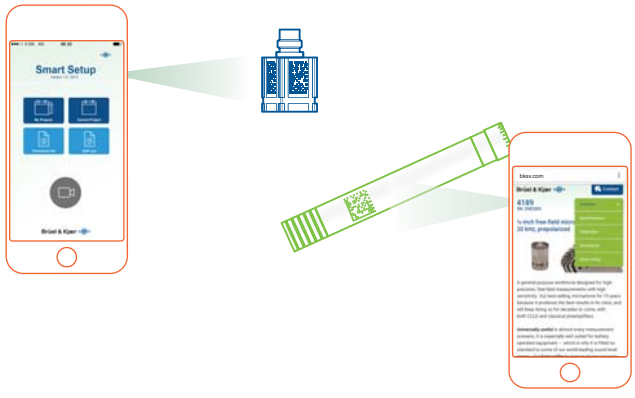
General guidelines for working with matrix codes

Selected Brüel & Kjær transducers feature matrix codes as laser engravings and/or printed labels. The matrix codes provide access to transducer information online as well as setup information designed for use with the Transducer Smart Setup app.

In this document, we discuss best practices for working with matrix codes.

To learn more about Transducer Smart Setup, you can:

- Scan any Brüel & Kjær transducer with a data matrix code and select Smart Setup from the drop-down menu
- Visit the Transducer Smart Setup page on bksv.com



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What are Matrix Codes?

Matrix codes are square or rectangular symbols that contain information. The basic element of a matrix code is the cell. Cells are small squares in two contrasting colours that are arranged in a specific pattern. The Quick Response (QR) Code* and data matrix are types of matrix codes.

Examples of information that can be encoded in a matrix code are: plain text (including logograms), Global Positioning System (GPS) coordinates, Uniform Resource Locators (URLs), phone numbers and email addresses.

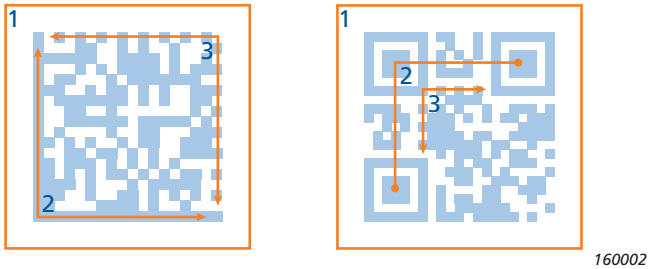

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Fig. 1
Basic anatomy of matrix codes.
***Left**: data matrix*
***Right**: QR Code*

Common Features

All matrix codes include:

- A quiet zone, indicated by (1). This is the empty area around the code that isolates it from the surroundings and prevents disruptions when reading the code
- Finder patterns, indicated by (2). Finder patterns serve to detect the code, determine its size, orientation, angle and any distortion (for example, codes on curved surfaces). In the data matrix code, the finder pattern is a solid L-shaped collection of cells. In a QR Code, the finder pattern is made of three square patterns located in three corners of the code
- Timing patterns, indicated by (3). This is a pattern of alternating light and dark cells. It contains a vertical and a horizontal arm. Timing patterns help to determine the size of the code, and to read distorted codes or codes at an angle. It can also indicate data capacity and version information, depending on the type of code

* QR Code is a registered trademark of DENSO WAVE INCORPORATED in Japan and in other countries

Error Correction

Many matrix codes have error correction features. Error correction can correct for a finite amount of unreadable cells. The data matrix codes on Brüel & Kjær transducers are version ECC 200 which uses Reed-Solomon error correction codes.

Brüel & Kjær Data Matrices

Data matrix codes on Brüel & Kjær transducers can be used in one of two ways: as a link to responsive web pages that clearly display information specific to the transducer on any device, and in combination with the Transducer Smart Setup app for multichannel test setup.

Orientation

The data matrix codes on Brüel & Kjær accelerometers are encoded with the accelerometer's orientation in a cartesian coordinate system. Each matrix code on an accelerometer is unique since each one encodes a unique orientation.

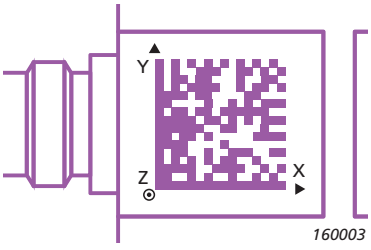

Fig. 2
Labelled symbols indicate the orientation of a triaxial accelerometer

The orientation is also indicated by labelled symbols (see Fig. 2). The finder pattern in the data matrix is used to represent two vectors in a cartesian coordinate system with arrows indicating their direction. Where the two vectors meet is a third vector, perpendicular to the other two. This third vector is marked with a circle. The circle contains either a dot or a cross. A dot indicates that the vector points outward, and a cross indicates that the vector points inward. The letters next to the arrows and circle label each vector.

Microphones

Microphone data matrices are not encoded with orientation information as their measurements are independent of a cartesian coordinate system. When using the Transducer Smart Setup app, set their DOF directions to scalar.

Reading a Matrix Code

Matrix codes are made of rows and columns of two-dimensional cells. Therefore, they are read with a device that can see in two dimensions. Matrix code reader applications for your mobile digital device use the installed camera to read the matrix code and an algorithm to decode it.

The maximum and minimum distances at which you can read a matrix code vary based on the size and quality of the matrix code, the type of reader you are using and environmental conditions such as lighting. As an example, Brüel & Kjær matrix codes are designed to be read at a distance of 10 cm (4 in) using the Transducer Smart Setup App installed on an Apple iPhone* in diffuse light.

Positioning the Reader

An important consideration when reading a matrix code is the relationship of the reader to the matrix code.

The best position from which to read the code is to place the reader parallel to the surface on which the code is printed with the code square in the viewfinder (see Fig. 3). However, if you are using the light source on your reader, move the reader so that it is slightly offset from parallel to avoid any surface reflections.

Note that there is a certain amount of freedom when reading matrix codes. The finder and timing patterns of matrix codes allow them to be read from multiple angles.

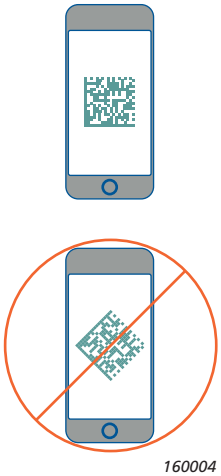

Fig. 3
Recommended orientation of the matrix code reader with respect to the matrix code

* iPhone is a trademark of of Apple Inc., registered in the U.S. and other countries

The following are things that affect the camera's ability to read a matrix code:

- Reflections
- Shadows
- Location
- Damage
- Background

Reflection

Reflected light, either from the matrix code or the surrounding surfaces, essentially blinds your camera. Reflections can occur from any light source, including the light on your mobile digital device.

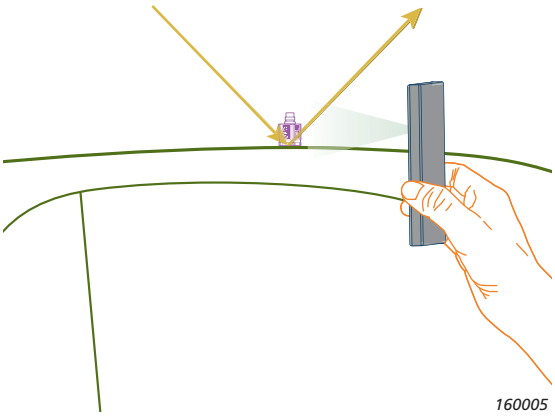

Fig. 4
Avoid light reflection when reading matrix codes

From an optical perspective, there are two types of transducer mounting surfaces to consider: matt surfaces and shiny (or glossy) surfaces. Matt surfaces absorb light and, hence, cause few problems when reading matrix codes. Shiny surfaces reflect light and do so in either a diffuse or specular manner. An example of diffuse reflection is sunlight reflecting off snow. An example of specular reflection is sunlight reflecting off a mirror.

Solution

If you are having problems due to specular reflection, note the light source and shape of the reflecting surface, then place the camera in such a way as to avoid reflection (see Fig. 4). You can also use a piece of paper or your hand to block the light source which can solve reading problems that result from either specular or diffuse reflection.

To avoid specular reflection from the camera's flash, move the camera slightly so that the light produced does not hit the reflecting surface at a right angle.

Shadows

Poor lighting can make it difficult for the camera to see the code. Shadows can be caused by either a lack of lighting as well as backlighting, which is illumination from behind. See Lighting below.

Solution

Illuminate the code with additional lighting or use the light on your mobile digital device. To reduce shadows caused by backlighting, hold a piece of paper between the code and the light source. This can effectively diffuse the light and reduce shadows.

Location

Matrix codes need to be completely visible through the viewfinder of the matrix code reader.

Solution

When possible, place the code in a location that allows you to scan it easily, away from objects that may partially block it.

Damage

Matrix codes have error correction features that allow them to be read even if the code is dirty or damaged. However, extensive dirt and damage can render the code unreadable.

Solution

If the unreadable matrix code is one that you generated, reprint it. In the case of Brüel &Kjær transducers with engraved data matrix codes, proper care and maintenance can keep the data matrices functional for a long time, see Care and Maintenance below.

Background
The camera in your matrix code reader must be able to distinguish the code from its surroundings. The colour of the background and the amount of clutter in it can prolong the time it takes for the camera to pick out the code.

Solution
Place the code in an area that enhances the contrast between the light and dark elements of the code, such as an undecorated, light-coloured surface. You can cover decorated or dark surfaces with paper. Clear the area of unnecessary items.

Lighting

The visibility of the matrix code is affected by lighting. The contrast level between the light and dark elements of a matrix code is key to successful readings. Reflections and shadows can make it impossible for the camera to see the contrast.

Here are a few lighting considerations:
- Avoid strong, direct lighting as it can cause reflections and shadows. Examples of lighting that can be too strong are sunlight and spotlights
- Diffuse lighting is the ideal condition for reading codes. Multiple light sources in a variety of locations and positions can produce an environment with diffuse lighting
- Fluorescent lighting and monitors can produce flickering in your camera's viewfinder, but should not affect its ability to read the code

Most lighting problems can be solved by adjusting the lighting with items you have at your disposal. You can use a piece of paper to shade the code from bright lights or the light on your mobile digital device to illuminate areas in shade.

Care and Maintenance

The following information is for the care and maintenance of Brüel & Kjær transducers that feature engraved data matrix codes.

Protect your transducer from unnecessary scratches and dents during mounting, use and removal. Error correction can compensate for some damage but it has its limits. Keep the surface of the transducer clean so that the matrix code is easily read. When not in use, it is always a good idea to store your transducer in its case.

Mounting Materials
The following mounting materials are safe to use on transducers with matrix code engravings:
- Mounting clips
- Cyanoacrylate
- Mounting grease
- Beeswax

Removal of Accelerometers
In the case of adhesive mountings, use a wrench (adjustable or otherwise) to gently twist off the accelerometer. The engraved matrix code is scratch resistent to light mechanical wear and tear, but excessive force can scratch or deform the surface of the transducer. Therefore, the use of tools such as screwdrivers, pliers and hammers is not recommended.

Cleaning

Dirt from mounting materials and the testing environment can accumulate on the surface of the transducer, making the matrix code impossible to read.

For cleaning, the following are safe to use on transducers with matrix code engravings:

- Alcohol – recommended for general cleaning
- Acetone – to remove cyanoacrylate
- Mild soap or dishwashing liquid

Remember to use protection, for example gloves and/or a mask, when using certain products to avoid harmful exposure.

Generating Matrix Codes

You can use a matrix code generator to make your own matrix codes. Many are available online with varying subscription plans and options. Mobile matrix code reader applications are another option as some include matrix code generators.

Printing

Print the code in a dark colour on light colored paper. The greater the contrast between the two colours, the easier it will be to read your code. Print on matte paper because it reflects less light than glossy paper.

Matrix Codes for Transducer Smart Setup

Data matrices or QR Codes can be generated for use with Transducer Smart Setup.

To create a matrix code that will enter transducer information in the correct fields, use this syntax:

Transducer type number/Transducer serial number

For example, you have a Type 1234-A transducer with serial number 1234567. Create a text matrix code which encodes this text: 1234A/1234567

To create a matrix code that will enter DOF information in the correct fields, use this syntax:

DOF/Component ID/Node ID

For example, you have a DOF Node with Component ID Left Wing and Node ID 3. Create a text matrix code which encodes this text: DOF/LeftWing/3

Do not include hyphens or spaces when entering the text you wish to encode.

Note that the forward slashes are a necessary component of the syntax.

For more information on how to use Transducer Smart Setup, including definitions of DOF Node, Component ID and Node ID, see the user manual for Transducer Smart Setup (BN 1706).

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