Application Note 2024

Ultrasonic Sensor Modules

NFD-enabled distance streamout

The TDK Ultrasonic Sensor Module (USSM) is able to continuously measure the distance to a specific object placed in front of it. It also takes into account the “dead zone” of the sensor using NFD (Near Field Detection) technology. This capability has been extensively customized. This document shows how to use and customize the sensor’s distance measurement capabilities.

Key characteristics

- Up to 50 frames per second
- 9 sensors in parallel
- Pitch-catch (configurable)
- Distance streamout
- NFD
- Filtering using NFD
- Customized solutions possible
- Ready-to-use software infrastructure

More information
www.tdk-electronics.tdk.com/en/ultrasonic_sensor_module
or contact your local sales office

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Overview

This Application Note shows how a maximum frame rate of 50 frames per second can be achieved, taking NFD into account. Several streamout modes were added to the demo firmware (version 20240705 and later).

These streamout modes allow the use to either:

1. **Mode 0:** sensors are operated sequentially (one after the other). This is the default streamout mode.
2. **Mode >0:** in pitch-catch or in parallel where high frame rates can be achieved.
   In this mode the user can select:
   a. **Mode 1:** distance values only
   b. **Mode 2:** distance values filtered by NFD flags
      - **For sending sensors:** If the NFD flag is high, the distance is reduced to 0 to indicate that an object was detected in the near field. Otherwise, the measured distance is output.
      - **For receive-only sensors:** The NFD is not taken into account, and the distance can be displayed to 0 (practically up to 3 cm).
   c. **Mode 3:** 2 values are displayed here for each sensor (distance followed by NFD status).

Note:

The streamout command is quite versatile and offers other parameters like:

- Sample time (default 100 ms)
- Number of iterations (default: -1, which means non-stop)
- Sensor selection (default: only sensor 0)
- Bursting or sending sensor mask (default: sensor 0)

Streamout command

The streamout command has the following structure:

sto[<sensor_mask>] <no._of_iterations> <delay_ms_between_iterations> <printout_mode> <master_mask>

- **sensor_mask** → mask of sensors to run the command on
  - For example, all sensors would have sensor_mask set to 0xFF.
  - The first two sensors would have sensor_mask set to 0x3.
- **no_of_iterations** → number of distance measurements
  - To run this infinitely, use -1.
- **delay_ms_between_iterations** → apply a delay between distance measurements
  - For no delay, use 0.
- **printout_mode** → sets the printout mode, there are 4 possible modes
  - Mode 0: captures and prints distances sequentially in cm for all selected sensors.
  - Mode 1: prints only distance in mm for selected sensors run in parallel.
  - **Mode 2: prints distance in cm if NFD flag is inactive, otherwise prints 0 to indicate obstacle is nearby**
  - Mode 3: prints distance in mm and NFD flag separately
  - Mode 4: prints only NFD flag
- **master_mask** → mask for master sensors
  Note: The nfd_flag printouts will function only on master sensors.

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Streamout command

For example, one valid command which triggers distance measurements on all sensors without delay and running indefinitely would be:

sto[0xFF] -1 0 2 0xFF;

In order to stop a continuous distance streamout command, the **end**; command must be used.

Examples

Mode 0

Command:
sto[0x3] -1 0 0 0x1;

Response:

32 34
29 34
25 27
24 29
24 24
25 24
21 23
20 22
19 21
19 21
26 35
30 34
33 33
31 34

Mode 1

Command:
sto[0x3] -1 0 1 0x1;

Response:

178 194
174 198
166 188
166 185
159 180
155 176
150 183
152 182
146 173
145 171
145 175
146 178
143 176
141 165
141 169
141 180
143 172

Mode 2

Command:
sto[0x3] -1 0 2 0x1;

Response:

30 29
30 29
30 29
30 30
30 29
0 28
0 28
0 27
0 27
0 25
0 24
0 25
0 24
0 25
0 26
0 27
0 27
0 29
29 29
29 30

Mode 3

Command:
sto[0x3] -1 0 3 0x1;

Response:

296 0 295 0
308 0 308 0
313 0 310 0
300 0 299 0
295 1 280 0
239 1 264 0
227 1 240 0
224 1 242 0
235 1 259 0
284 1 282 0
300 0 304 0
304 0 310 0
292 0 295 0
252 1 270 0
230 1 250 0

Mode 4

Command:
sto[0x3] -1 0 4 0x1;

Response:

1 0
1 0
1 0
1 0
1 0
0 0
0 0
0 0
1 0
1 0
1 0
1 0

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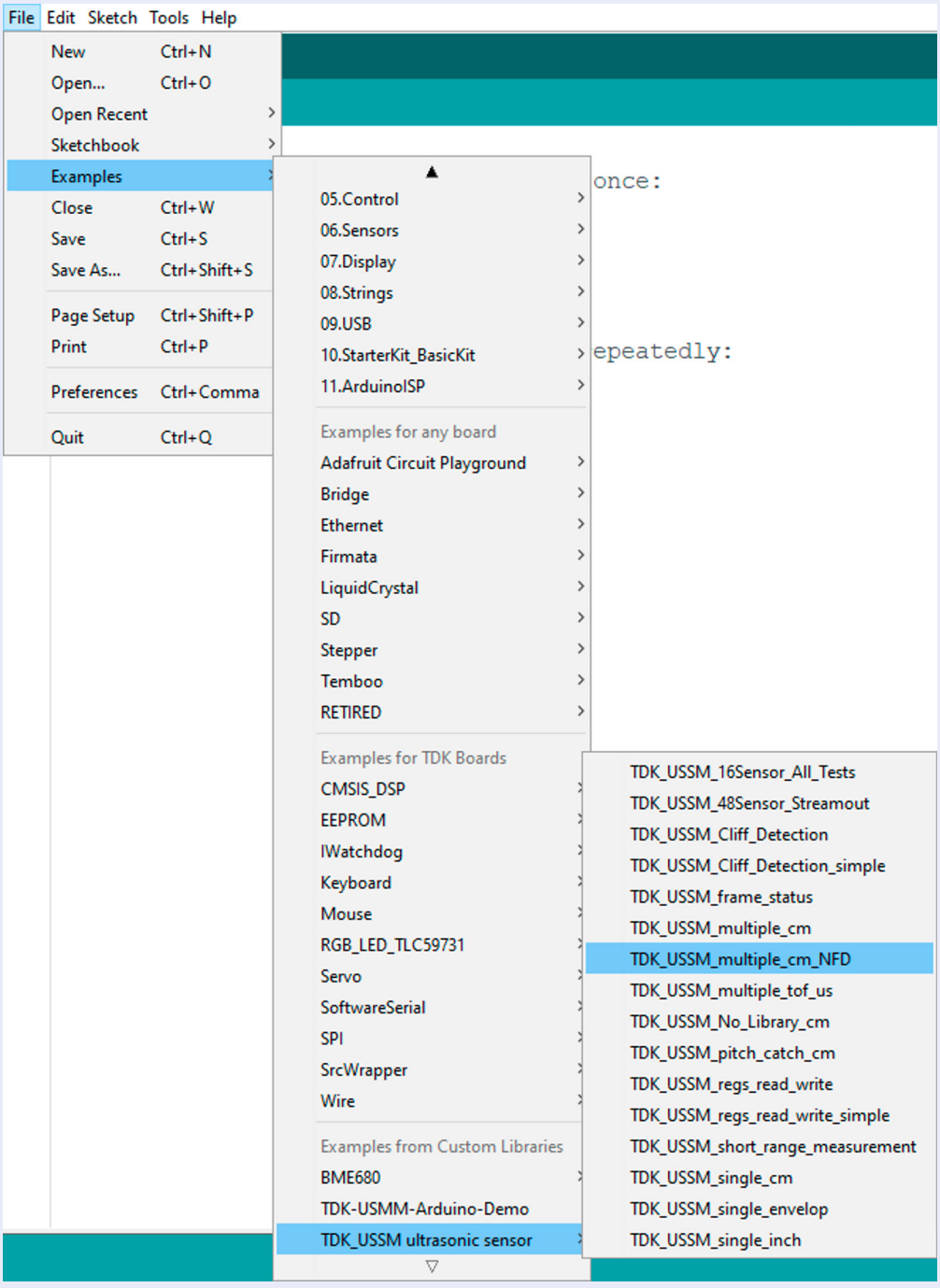
Do it yourself (DIY) using the Arduino® Library

In addition to the streamout command, which is available by default in the board firmware, further examples of distance streamout capabilities can be found in the TDK USSM Library (**version 1.0.2 and higher**). This is Arduino-compatible and readily available on the TDK USSM website. The examples available in the library are compatible with all TDK USSM boards. This section guides you through the installation steps.

For more information on how to use the library with any Arduino-compatible boards, please refer to the Arduino setup Application Note.



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Installation steps

1. Install the TDK USSM Library

a. The library is available under **TDK_USSM_Ultrasonic_Sensor_Library-X.X.X.zip**

b. To include the library, open the Arduino IDE and head to Tools → Include Library → Add .ZIP library and select the file mentioned above.

c. Ensure the library location is correct

- The file path should be something like: C:\Users*your username*\Documents\Arduino\libraries

d. Restart the Arduino IDE

2. Upload the example to the board

a. Under the examples supplied with the board, look for TDK_USSM_multiple_cm_NFD (as shown in the screenshot on page 4)

b. Upload the example to the board

3. Check for response

a. Open the **Serial Monitor**

b. Observe the response

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