AN4184

Application note

Microphone coupon boards STEVAL-MKI129Vx /MKI155Vx based on digital microphones

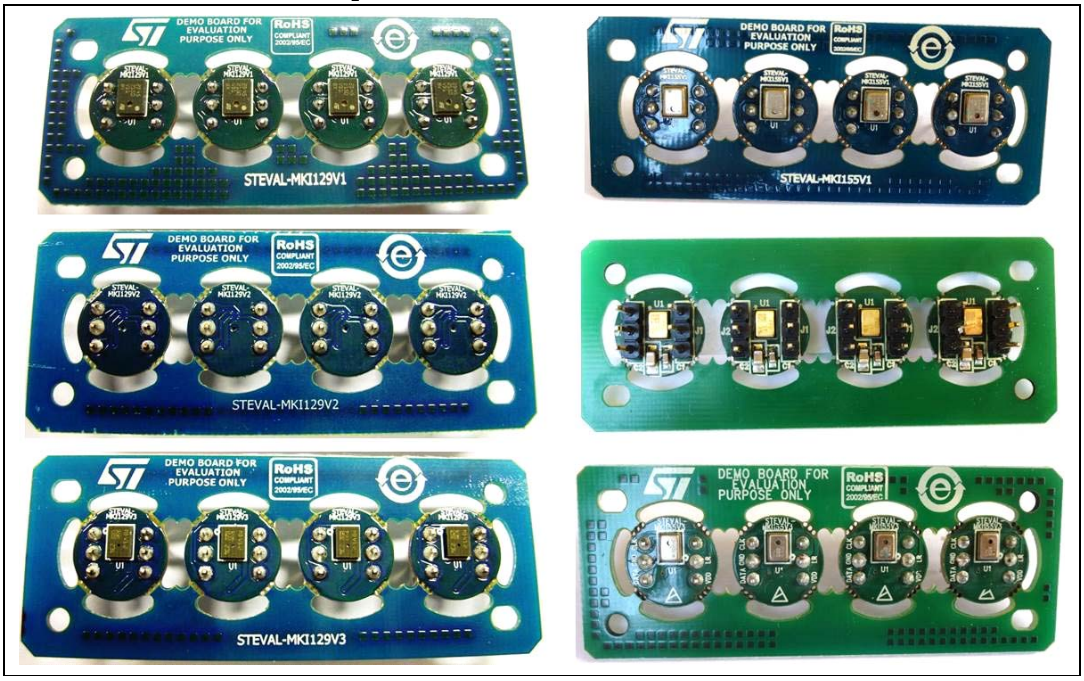
Introduction

This application note briefly describes the microphone coupon boards STEVAL-MKI129Vx / MKI155Vx from STMicroelectronics based on digital microphones.

The boards are offered in three different versions, depending on the hosted microphone:

- STEVAL-MKI129V1 for the MP45DT02
- STEVAL-MKI129V2 for the MP34DB01
- STEVAL-MKI129V3 for the MP34DT01
- STEVAL-MKI155V1 for the MP45DT02-M
- STEVAL-MKI155V2 for the MP34DB02
- STEVAL-MKI155V3 for the MP34DT01-M

Figure 1. STEVAL-MKI129V1/V2/V3



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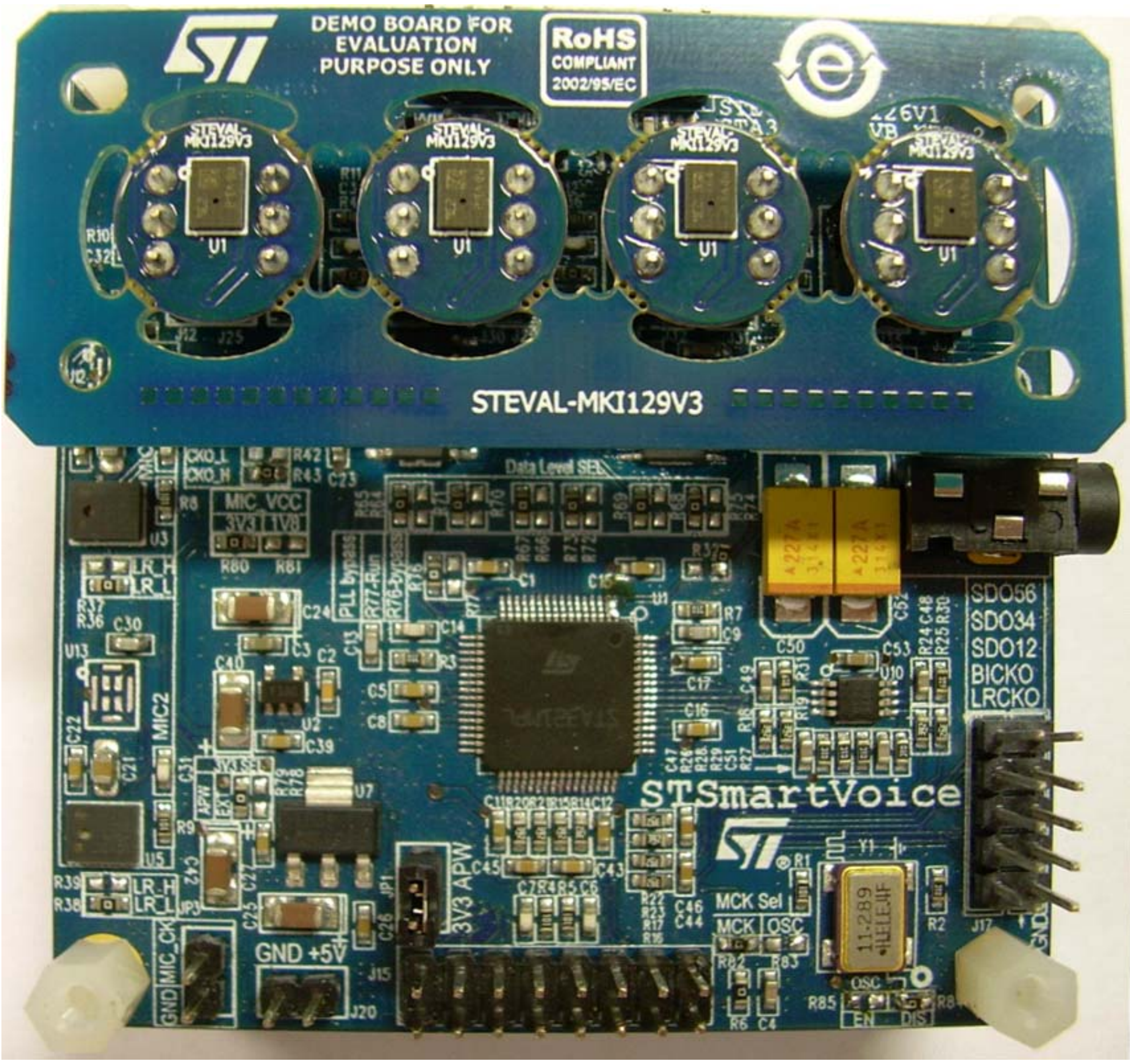
1 Description

The STEVAL-MKI129Vx and MKI155Vx boards are the daughterboards used in the STEVAL-MKI126 kit. For additional details, please refer to AN4146 " STSmartVoice demonstration board STEVAL-MKI126Vx" available on www.st.com.

The STEVAL-MKI126 board hosts four groups of three female headers as depicted in the figure below. The J12, J25 and J26 group can host one of the three different types of microphone audio adapters. The single PCB, hosting one microphone, can also be detached and used alone.

Figure 2. Connections of microphone audio adapters



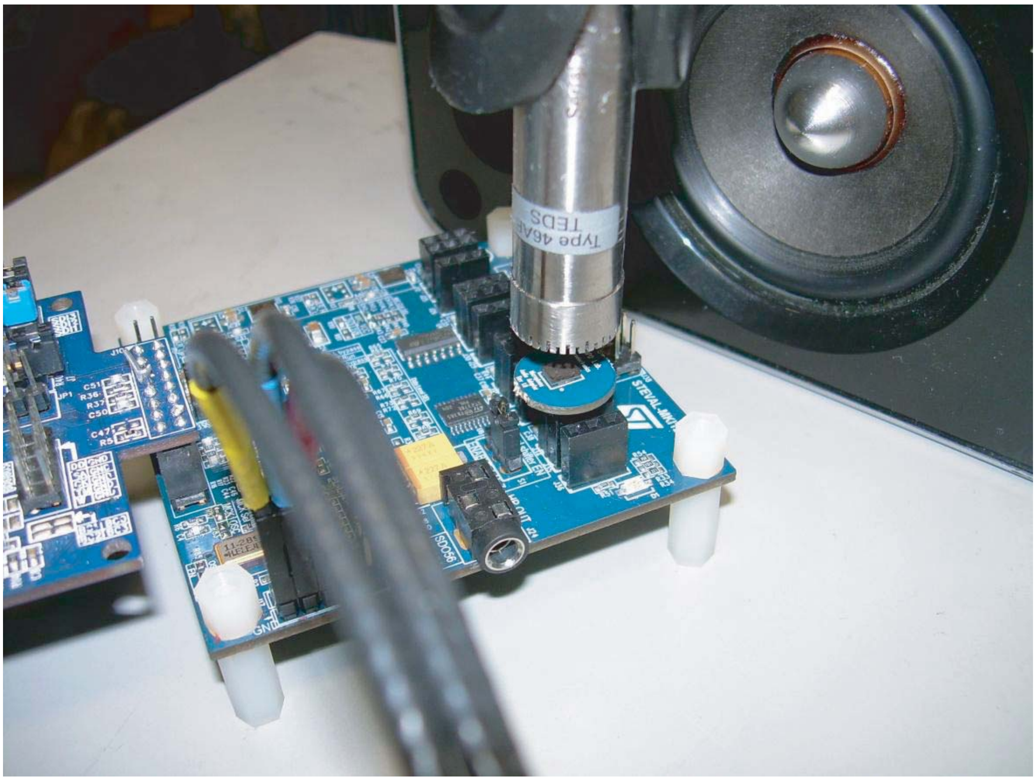
2 Microphone measurements

One of the benefits of using the combination of these two kits STEVAL-MKI126 and STEVAL-MKI129 or STEVA-MKI155 is the measurement of the different models of the microphone. In this section a brief description of the microphone evaluation will be given.

The equipment used to measure the main parameters of a microphone is listed as follows:

- Interface boards APWlink or ST audio hub (STEVAL-CCA035V1 or STEVAL-MKI138Vx respectively)
- STSmartVoice board (STEVAL-MKI126Vx)
- Coupon board of the MP34DT01 (STEVAL-MKI129V3)
- Reference microphone (G.R.A.S. Type 46AE)
- Generic loudspeaker
- Audio precision (Model 2722)

Figure 3. Test setup



The test is done by performing a synchronous acquisition of a couple of microphones, the first is the reference calibrated microphone, the second is the device under test (DUT). The two microphones are placed face-to-face to minimize the sound pressure differences between the membranes of the two devices.

The reference microphone is used, exploiting the known parameters, to find the reference in the acoustic domain. Once the sound pressure level near the membranes of the microphones has been set to 1 PA, then by performing a reading of the DUT amplitude, the sensitivity is found. The reference microphone is also used to measure the DUT frequency response through a comparison between their sensitivities across the audio band. Since the reference microphone is an analog device, the analog interface of the STSmartVoice has to be used in order to ensure synchronous measurements (refer to AN4146 for details on using the board).

Table 1 summarizes the main features and corresponding values of the three MEMS microphones, followed by figures showing the frequency response of each device.

Table 1. Main parameters of ST's digital MEMS microphones

Features	ST MEMS MP45DT02	ST MEMS MP34DB01	ST MEMS MP34DT01
Sensitivity	-26 dBFS	-26 dBFS	-26 dBFS
S/N	61 dB	62 dB	63 dB
Directivity	OMNI directional	OMNI directional	OMNI directional
Lead free reflow issue	no	no	no
Current consumption	20 µA (sleep) 650 µA	20 µA (sleep) 600 µA	20 µA (sleep) 600 µA
Package dimensions	4.72 x 3.76 x 1.25 mm	3 x 4 x 1 mm	3 x 4 x 1 mm
Operating temperature	-40°C < T < +85°C	-30°C < T < +85°C	-30°C < T < +70°C

Figure 4. MP45DT02 frequency response (STEVAL-MKI129V1)

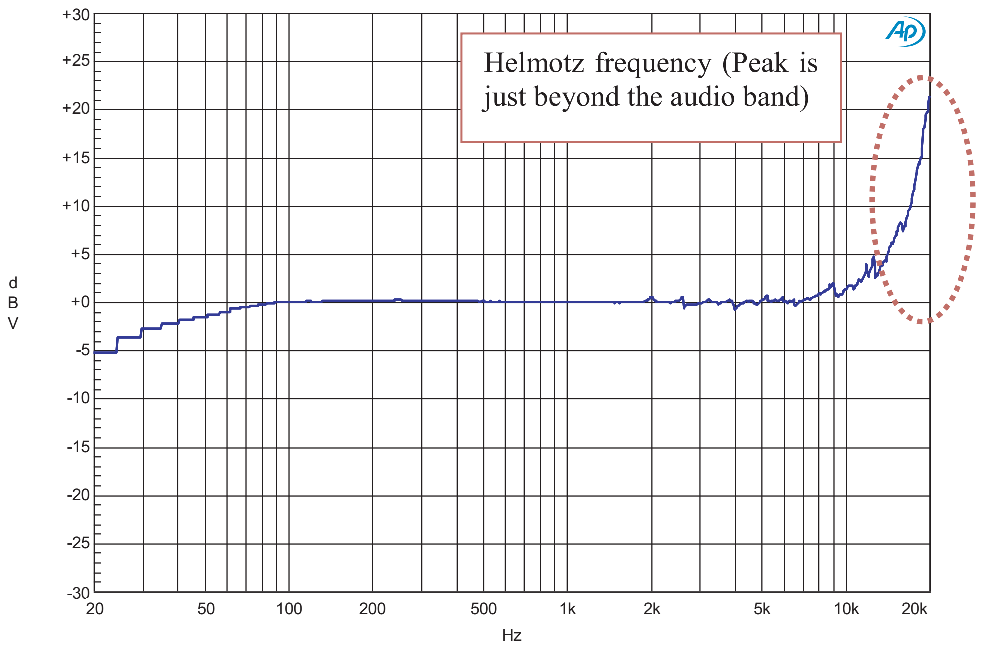


Figure 5. MP34DB01 frequency response (STEVAL-MKI129V2)

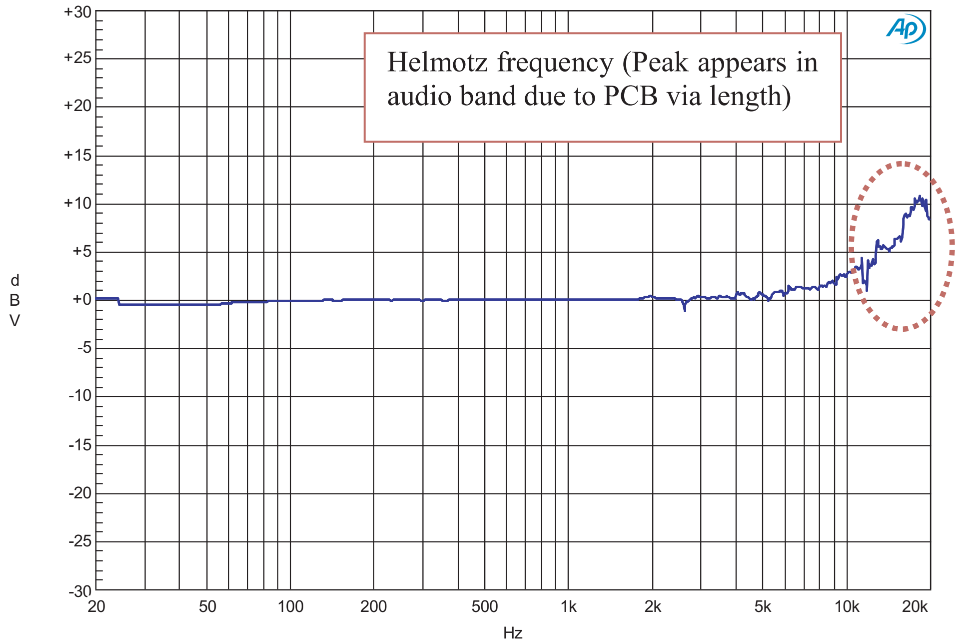
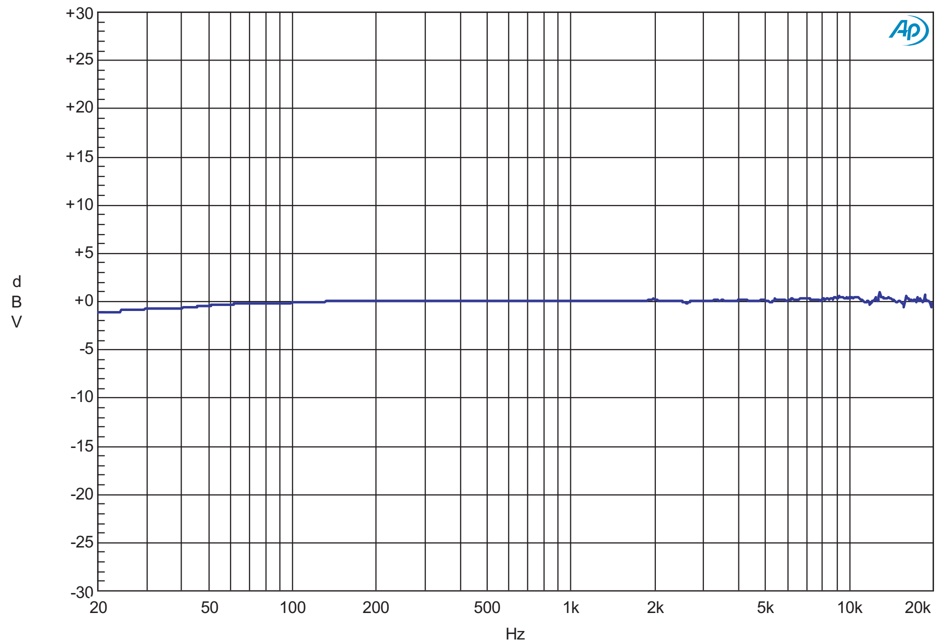


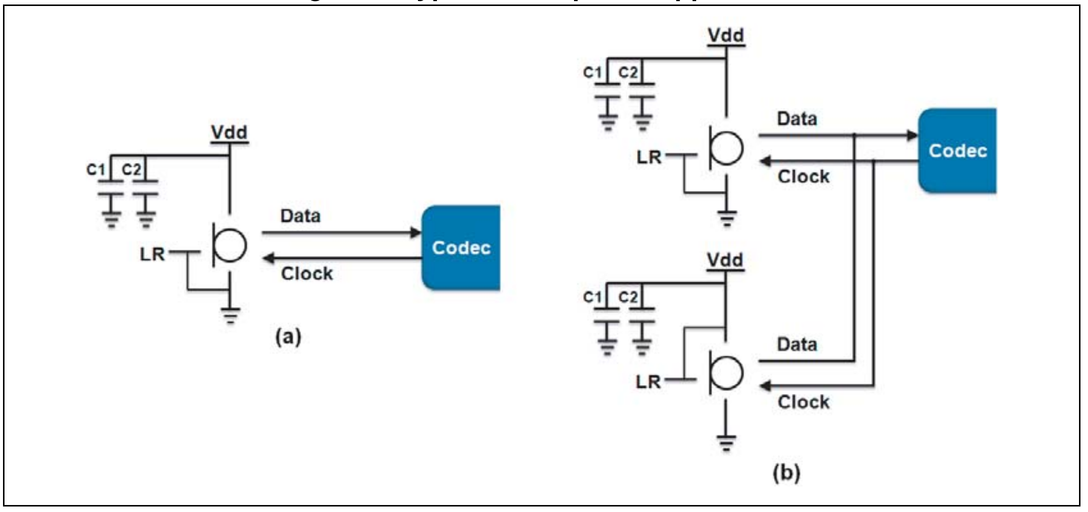
Figure 6. MP34DT01 frequency response (STEVAL-MKI129V3)



3 Schematic hints

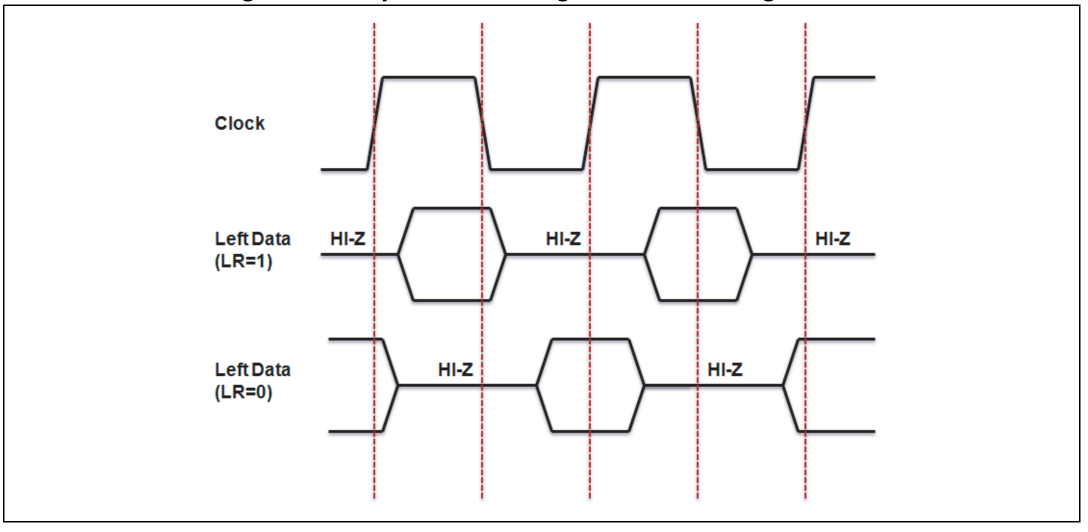
Digital microphones frequently operate in an environment where a codec provides the suitable clock and consequently accepts the digital data of the microphone. *Figure 7* below depicts the two typical connections, part (a) shows the usage of the microphone in mono mode, and part (b) shows the stereo mode.

Figure 7. Typical microphone application



Concerning the stereo configuration, the LR pins of the involved digital microphones must be respectively set to Vdd and gnd. This setting will produce the output signals depicted in *Figure 8* below. The succession of data valid and Hi-Z allows shortening the digital outputs between each other to share the same data line.

Figure 8. Output data timing in stereo configuration



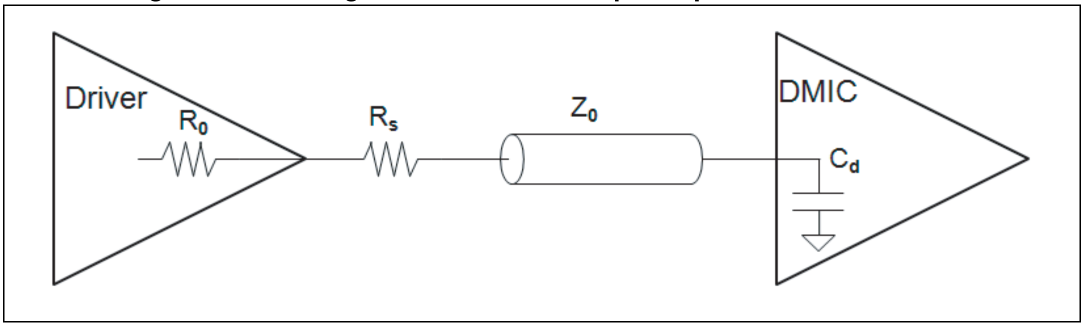
Concerning the schematic, the project must follow the recommended connections of *Figure 7* according to the desired configuration. Additionally, two capacitors (C1 and C2) can be considered to ensure suitable supply decoupling. Generally, ST recommends two different values, C2 = 10 µF working at low frequency and C1 = 100 nF working in the higher frequency domain. These capacitors are the recommended values when the application board supply voltage contains noise, they are not mandatory if the supply voltage is relatively clean. If the designer can use only one capacitor, C1 =100 nF is the recommended choice.

Impedance matching is another important topic that merits consideration in the design of the board. Nowadays the use of microphones in applications such as smartphones, laptops or tablets host these devices pretty far from the codec or even on a separate PCB connected by flexible cables. In any case, every involved component (the codec, the digital microphone and the trace) shows its own impedance. The mismatch of the impedance will generate multiple reflections on the transmission line, causing a degradation of the performance and probable EMI issues. The way to avoid such reflections consists of adding components, which allows matching the impedance. Recommended clock trace termination methods are given below and on the following pages.

Method 1

Series resistor: $R_S = Z_0 - R_0$

Figure 9. Matching the clock driver output impedance - driver side

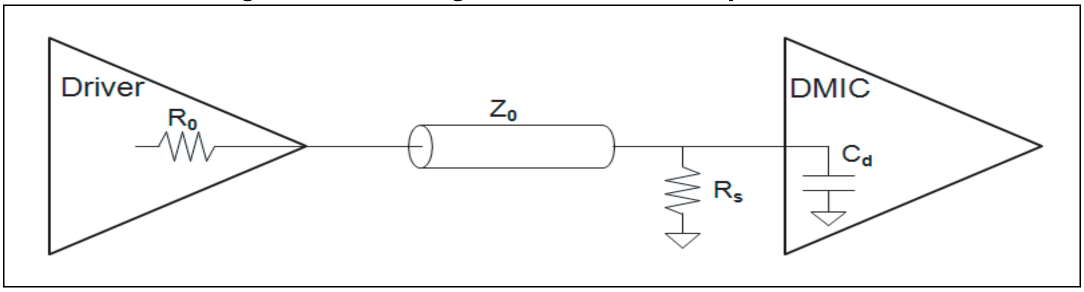


The series resistor R_S added at the output of the driver is used to match the impedance between the driver output and that shown by the transmission line. The advantage of this solution is that its implementation is very easy. This solution will impact the speed of the rising and falling edges. Reducing the speed of the edges will help, considering that the EMI issue conversely causes the increase of the delay introduced by the transmission line.

Method 2

Shunt resistor: $R_s = Z_0$

Figure 10. Matching the PCB line - microphone side



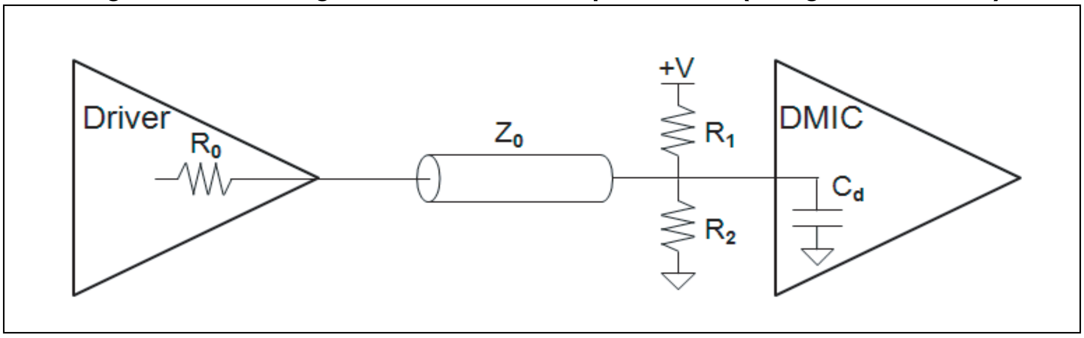
This solution is the same as that presented in *Method 1*, but concerns the microphone side. It is a very easy solution to implement as well but can introduce non-negligible extra power consumption. It also causes asymmetrical rising and falling clock edges.

Method 3

Two resistors:

$$\frac{R_1 \bullet R_2}{R_1 + R_2} = Z_0$$

Figure 11. Matching the PCB line - microphone side (using two resistors)



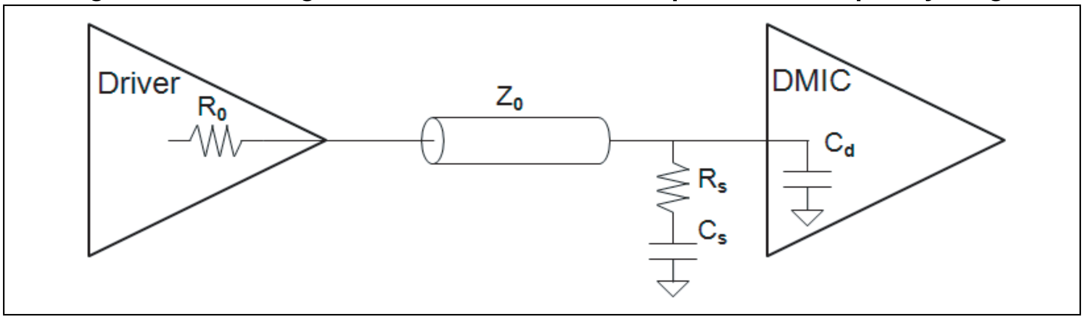
The solution in *Method 3* is very similar to *Method 2*. This is impedance matching on the microphone side done with two resistors, allowing less power consumption and symmetrical rising and falling edges of the clock, however the number of components represents a drawback.

Method 4

Shunt resistor: $R_S = Z_0$

Series capacitor to obtain $\tau = R_S * C_S > 2T_{PD}$ (T_{PD} line propagation delay)

Figure 12. Matching the PCB line near the microphone in a frequency range

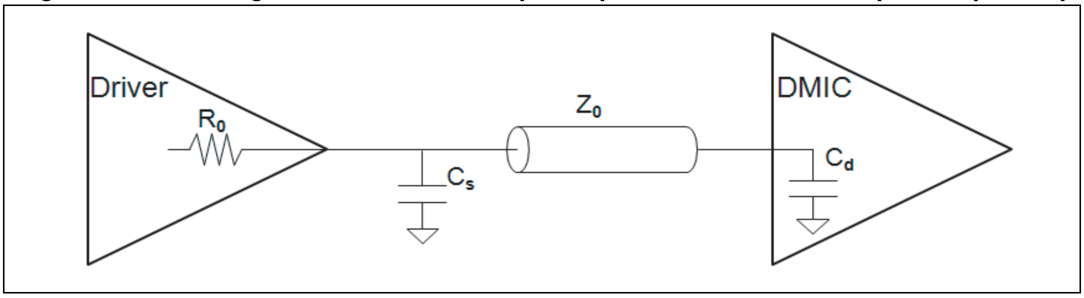


Basically this network works in the same way as that shown in *Method 2*, but only above a fixed frequency. This frequency depends on the time constant fixed by the resistor and capacitor and it must be chosen greater than twice the propagation time delay. This is a very useful solution, but it impacts the rising and falling edge of the clock and the transmission line delay.

Method 5

Shunt capacitor where $R_0 = Z_0 (j\omega) \text{ II } C_S$

Figure 13. Matching the clock driver output impedance - driver side (with capacitor)



The capacitor C_S added at the output of the driver is used to match the impedance between the driver output and that shown by the transmission line. The advantage of this solution is that its implementation is very easy. It introduces negligible extra current consumption and, as in *Method 4*, impacts the rising and falling edge of the clock.

Any of these solutions can be used to avoid the reflections on the transmission line, the designer must select the method which is best suited to his application. The STEVAL-MKI129Vx coupon boards do not implement these techniques since their use is for promotional and debugging proposes only.

The C_d capacitor in the previous figures represents the impedance shown by the digital input of the MEMS microphones offered by STMicroelectronics. It is not included in the previous equations because the methods listed are provided in order to properly terminate the codec or the microphone with the transmission line; this capacitor simply impacts the propagation delay.

4 Evaluation boards details

4.1 STEVAL-MKI129V1 board details

Figure 14. STEVAL-MKI129V1 schematic

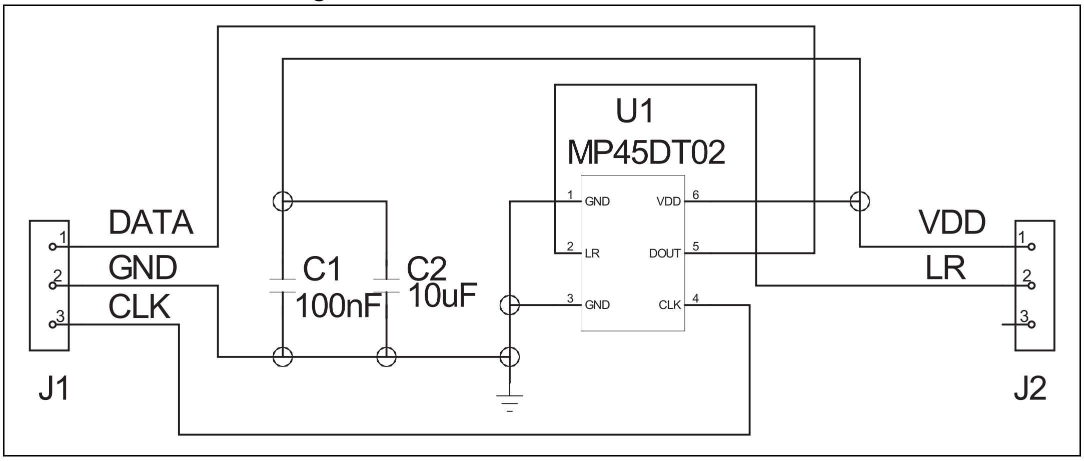


Table 2. Bill of material - STEVAL-MKI129V1 (MP45DT02)

Designator	Type	Description	Footprint	Manufacturer
C1	Capacitor	100 nF, 16 V, ±10%	CAP0603	Murata
C2	Capacitor	10 µF, 10 V, ±10%	CAP0805	Murata
J1, J2	Pin array	Header 2.5 mm x 3 (male)	Header (male)	Any source
U1	Microphone	MP45DT02	MP45DT02	STMicroelectronics

Figure 15. STEVAL-MKI129V1 layout - top view

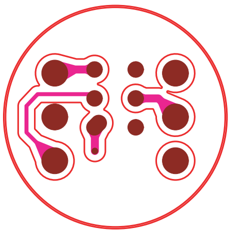
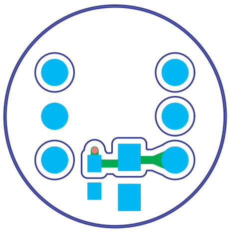


Figure 16. STEVAL-MKI129V1 layout - bottom view



4.2 STEVAL-MKI129V2 board details

Figure 17. STEVAL-MKI129V2 schematic

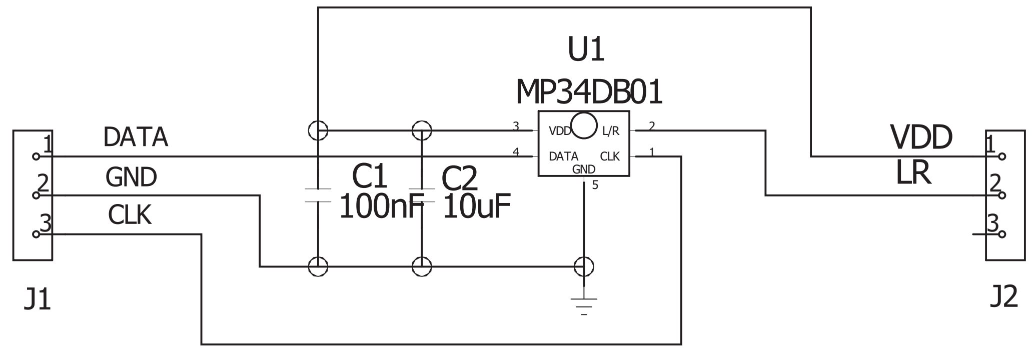


Table 3. Bill of material - STEVAL-MKI129V2 (MP34DB01)

Designator	Type	Description	Footprint	Manufacturer
C1	Capacitor	100 nF, 16 V, ±10%	CAP0603	Murata
C2	Capacitor	10 µF, 10 V, ±10%	CAP0805	Murata
J1, J2	Pin array	Header 2.5 mm x 3 (male)	Header (male)	Any source
U1	Microphone	MP34DB01	MP34DB01	STMicroelectronics

Figure 18. STEVAL-MKI129V2 layout - top view

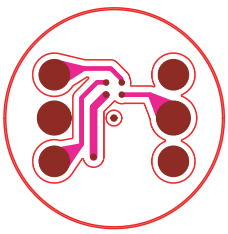
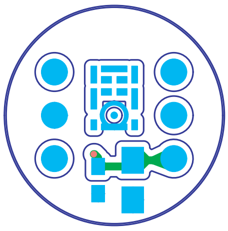


Figure 19. STEVAL-MKI129V2 layout - bottom view



4.3 STEVAL-MKI129V3 board details

Figure 20. STEVAL-MKI129V3 schematic

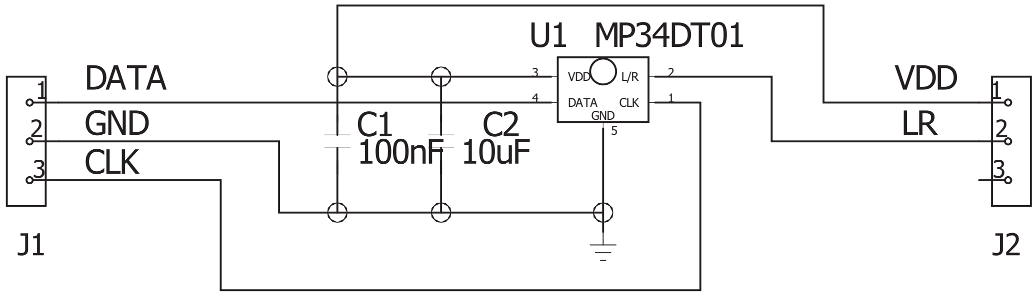


Table 4. Bill of material - STEVAL-MKI129V3 (MP34DT01)

Designator	Type	Description	Footprint	Manufacturer
C1	Capacitor	100 nF, 16 V, ±10%	CAP0603	Murata
C2	Capacitor	10 µF, 10 V, ±10%	CAP0805	Murata
J1, J2	Pin array	Header 2.5 mm x 3 (male)	Header (male)	Any source
U1	Microphone	MP34DT01	MP34DT01	STMicroelectronics

Figure 21. STEVAL-MKI129V3 layout - top view

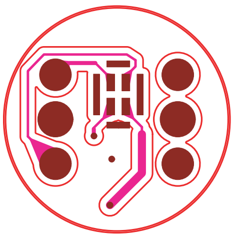


Figure 22. STEVAL-MKI129V3 layout - bottom view

4.4 STEVAL-MKI155V1 board details

Figure 23. STEVAL-MKI155V1 schematic

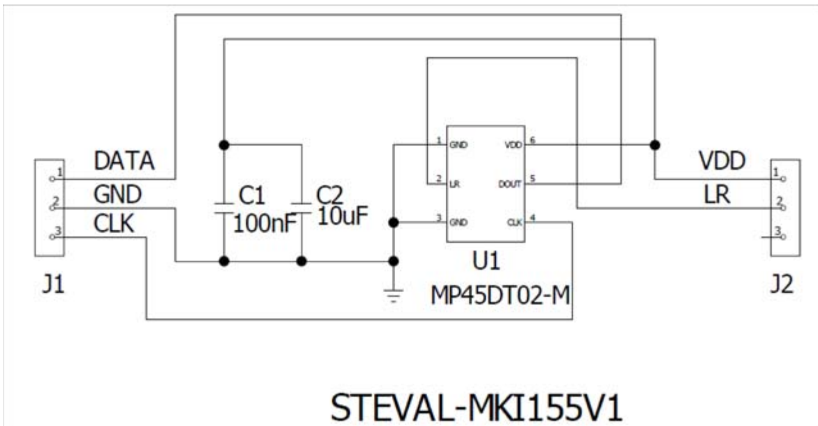


Table 5. Bill of material - STEVAL-MKI155V1 (MP45DT02-M)

Designator	Type	Description	Footprint	Manufacturer
C1	Capacitor	100 nF, 16 V, ±10%	CAP0603	Murata
C2	Capacitor	10 µF, 10 V, ±10%	CAP0805	Murata
J1, J2	Pin array	Header 2.5 mm x 3 (male)	Header (male)	Any source
U1	Microphone	MP45DT02-M	MP45DT02-M	STMicroelectronics

Figure 24. STEVAL-MKI155V1 layout - top view

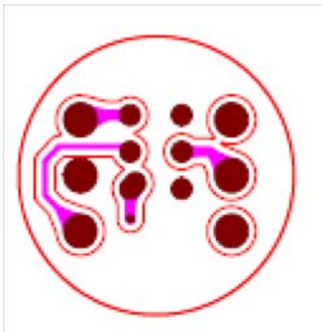


Figure 25. STEVAL-MKI155V1 layout - bottom view

4.5 STEVAL-MKI155V2 board details

Figure 26. STEVAL-MKI155V2 schematic

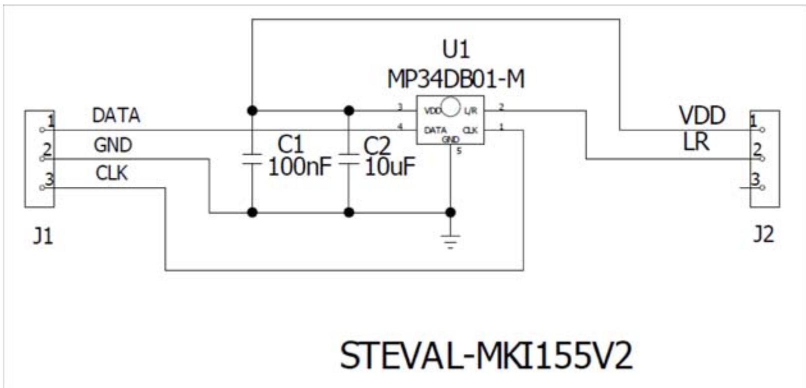


Table 6. Bill of material - STEVAL-MKI155V2 (MP34DB02)

Designator	Type	Description	Footprint	Manufacturer
C1	Capacitor	100 nF, 16 V, ±10%	CAP0603	Murata
C2	Capacitor	10 µF, 10 V, ±10%	CAP0805	Murata
J1, J2	Pin array	Header 2.5 mm x 3 (male)	Header (male)	Any source
U1	Microphone	MP34DB02	MP34DB02	STMicroelectronics

Figure 27. STEVAL-MKI155V2 layout - top view

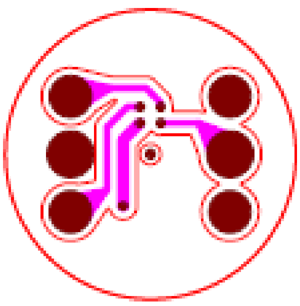


Figure 28. STEVAL-MKI155V2 layout - bottom view

4.6 STEVAL-MKI155V3 board details

Figure 29. STEVAL-MKI155V3 schematic

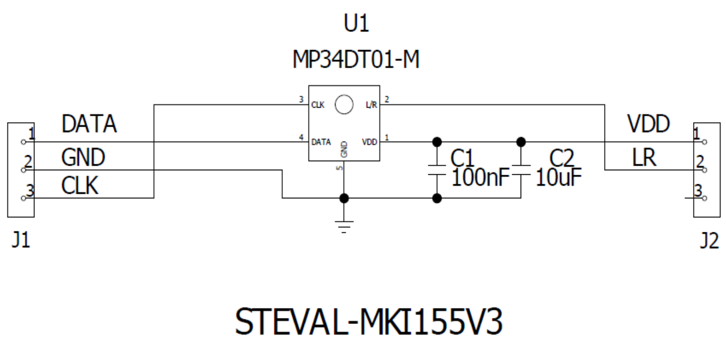
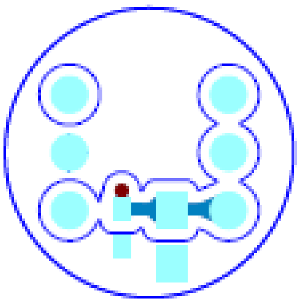


Table 7. Bill of material - STEVAL-MKI155V3 (MP34DT01-M)

Designator	Type	Description	Footprint	Manufacturer
C1	Capacitor	100 nF, 16 V, ±10%	CAP0603	Murata
C2	Capacitor	10 µF, 10 V, ±10%	CAP0805	Murata
J1, J2	Pin array	Header 2.5 mm x 3 (male)	Header (male)	Any source
U1	Microphone	MP34DT01-M	MP34DT01-M	STMicroelectronics

Figure 30. STEVAL-MKI155V3 layout - top view

Figure 31. STEVAL-MKI155V3 layout - bottom view



5 Revision history

Table 8. Document revision history

Date	Revision	Changes
12-Mar-2013	1	Initial release
21-Jul-2014	2	Added STEVAL-MKI155Vx family