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## VERSION HISTORY

<table>
<thead>
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<th>Version</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
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<td>1.0</td>
<td>First version</td>
</tr>
<tr>
<td>1.1</td>
<td>Schematic 4/5 corrected</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

1  Introduction..................................................................................................................................................5

2  Hardware Design of DKWT32i v2 ..................................................................................................................6
2.1 Choosing the Capacitors and Resistors Used in the Audio Path ..............................................................6
2.2 How to Avoid Pops and Cracks When Powering the Board or Establishing A2DP connection ..........7
2.3 Schematic and Assembly of DKWT32i v2 ....................................................................................................9
2.4 Layout of DKWT32i ..................................................................................................................................15
2.5 RF, EMC and Audio Layout Considerations ..............................................................................................17

3  Contact Information ....................................................................................................................................19
1 Introduction

This document describes the detailed design of the WT32i development kit.
2  Hardware Design of DKWT32i v2

2.1  Choosing the Capacitors and Resistors Used in the Audio Path

Metal film resistors have lower noise than carbon resistors which makes them more suitable for high quality audio.

Non-linearity of capacitors within the audio path will have an impact on the audio quality at the frequencies where the impedance of the capacitors become dominant. At higher frequencies the amplitude is not determined by the value of the capacitors, but at the lower frequencies the impact of the capacitors will be seen.

Ceramic capacitors should be X5R or X7R type capacitors with relative high voltage rating. The higher the capacitance value, the lower is the frequency where the non-linearity will start to have an impact. Thus it is not a bad idea to select the capacitors value bigger than necessary from the frequency response point of view.

For optimal audio quality the best selection is to use film capacitors. Film capacitors have excellent linearity and they are non-polarized which makes them perfect choice for using in audio path. The drawback of film capacitors is bigger physical size and higher cost.

Figure 1 shows a modulation distortion measurement when using different type of capacitors in the audio paths. Modulation distortion measures the amount of distortion between two closely located sine waves. The difference between the different capacitors is obvious at low frequencies where the impedance of the capacitor is dominant.

![Figure 1: Intermodulation distortion with different type of capacitors](image-url)
2.2 How to Avoid Pops and Cracks When Powering the Board or Establishing A2DP connection

To match the impedances $Z_1$ and $Z_2$ it is important that the capacitors at the input of the amplifier are well matched together. The tolerance of a ceramic chip capacitor is typically in the range of 5% - 20% and generally ceramic capacitors are more accurate than film capacitors. Thus in this case ceramic X7R capacitors with 5% tolerance were chosen for the external audio PA to minimize the pop sound when the A2DP link is established or switched off.

![Figure 2: Extenal audio PA connection](image-url)

To avoid common mode transient at the input to cause transient at the output, $Z_1$ must be equal to $Z_2$.

$$C_2 = \frac{C_3}{2} \quad \text{and} \quad R_4 = R_5 = R_6$$
Figure 3: Equivalent circuit for simulating the transient caused by the impedance mismatch
2.3 Schematic and Assembly of DKWT32i v2

Figure 4: DKWT32i v2 Schematic (1/5)
Figure 6: DKWT32i v2 Schematic (3/5)

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Figure 7: DKWT32i v2 Schematic (4/5)

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Figure 8: DKWT32i v2 Schematic (5/5)

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Figure 9: WT32i Development Board Assembly Drawing
2.4 Layout of DKWT32i

Figure 10: Top layer layout of DKWT32i contains signal and audio tracing

Figure 11: 2nd layer layout of DKWT32i contains a solid GND plane
Figure 12: 3rd layer layout of DKWT32i contains supply voltages

Figure 13: Bottom layer layout of DKWT32i contains GND and signal tracing
2.5 RF, EMC and Audio Layout Considerations

GND planes are stitched with vias at the edges of the PCB to prevent emissions.
GND vias are placed right next to any GND pad to connect GND pads directly to the solid GND plane. This is to make sure that the return current path is low impedance without any loops.

Figure 14: GND vias in DKWT32i

Differential audio signals are traced parallel to make sure they have perfect common mode rejection. All the audio traces are routed on a solid GND plane.

Figure 15: Routing of differential audio signals
GND plane is required on both sides of the Antenna. The antenna uses the GND plane as a part of radiator and the lack of GND plane will significantly reduce the performance.

Metal clearance area under the antenna. Antenna placed at the edge of the PCB.

Figure 16: Clearance area under the antenna
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