1. Product profile

1.1 General description

The device is designed to protect high-speed interfaces such as Transition Minimized Differential Signaling (TDMS) lines of High-Definition Multimedia Interface (HDMI), standard 2.0 and lower, against ElectroStatic Discharge (ESD).

The device includes four high-level ESD protection diode structures for ultra high-speed signal lines and is encapsulated in a leadless small DFN2510A-10 (SOT1176-1) plastic package.

All signal lines are protected by a special diode configuration offering ultra low line capacitance of only 0.5 pF. These diodes utilize a unique snap-back structure in order to provide protection to downstream components from ESD voltages up to ±10 kV contact exceeding IEC 61000-4-2, level 4.

1.2 Features and benefits

- System ESD protection for HDMI, standard 2.0 and lower.
- All signal lines with integrated rail-to-rail clamping diodes for downstream ESD protection of ±10 kV exceeding IEC 61000-4-2, level 4
- Matched 0.5 mm trace spacing
- Signal lines with ≤ 0.05 pF matching capacitance between signal pairs
- Line capacitance of only 0.5 pF for each channel
- Design-friendly ‘pass-through’ signal routing

1.3 Applications

The device is designed for high-speed receiver and transmitter port protection:

- TVs and monitors
- DVD recorders and players
- Notebooks, main board graphic cards and ports
- Set-top boxes and game consoles
2. Pinning information

Table 1. Pinning

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Graphic symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH1</td>
<td>channel 1 ESD protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CH2</td>
<td>channel 2 ESD protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CH3</td>
<td>channel 3 ESD protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CH4</td>
<td>channel 4 ESD protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>n.c.</td>
<td>not connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>n.c.</td>
<td>not connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>n.c.</td>
<td>not connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>n.c.</td>
<td>not connected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Ordering information

Table 2. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package Name</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHDMI2F4</td>
<td>DFN2510A-10</td>
<td>plastic extremely thin small outline package; no leads; 10 terminals; body 1 × 2.5 × 0.5 mm</td>
<td>SOT1176-1</td>
</tr>
</tbody>
</table>

4. Marking

Table 3. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHDMI2F4</td>
<td>96</td>
</tr>
</tbody>
</table>

5. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_1</td>
<td>input voltage</td>
<td>IEC 61000-4-2, level 4</td>
<td>-0.5</td>
<td>+5.5</td>
<td>V</td>
</tr>
<tr>
<td>V_ESD</td>
<td>electrostatic discharge voltage</td>
<td>contact discharge</td>
<td>-10</td>
<td>+10</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>air discharge</td>
<td>-15</td>
<td>+15</td>
<td>kV</td>
</tr>
<tr>
<td>T_amb</td>
<td>ambient temperature</td>
<td></td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
</tr>
<tr>
<td>T_stg</td>
<td>storage temperature</td>
<td></td>
<td>-55</td>
<td>+125</td>
<td>°C</td>
</tr>
</tbody>
</table>

[1] All pins to ground.
6. Characteristics

Table 5. Characteristics

\[T_{amb} = 25 \, ^\circ \mbox{C unless otherwise specified.}\]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{BR})</td>
<td>breakdown voltage</td>
<td>(I_I = 1 , \text{mA})</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>(I_{LR})</td>
<td>reverse leakage current</td>
<td>per channel; (V_I = 3 , \text{V})</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td>(V_F)</td>
<td>forward voltage</td>
<td>(I_I = 1 , \text{mA})</td>
<td>-</td>
<td>0.7</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>(C_{line})</td>
<td>line capacitance</td>
<td>(f = 1 , \text{MHz}; , V_I = 3.3 , \text{V})</td>
<td>0.5</td>
<td>0.6</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>(\Delta C_{line})</td>
<td>line capacitance difference</td>
<td>(f = 1 , \text{MHz}; , V_I = 3.3 , \text{V})</td>
<td>0.05</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>(r_{dyn})</td>
<td>dynamic resistance</td>
<td>surge</td>
<td>-</td>
<td>0.41</td>
<td>-</td>
<td>(\Omega)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>positive transient</td>
<td>-</td>
<td>0.26</td>
<td>-</td>
<td>(\Omega)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>negative transient</td>
<td>-</td>
<td>0.43</td>
<td>-</td>
<td>(\Omega)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TLP</td>
<td>-</td>
<td>0.28</td>
<td>-</td>
<td>(\Omega)</td>
</tr>
<tr>
<td>(V_{CL})</td>
<td>clamping voltage</td>
<td>(I_{PP} = 5.2 , \text{A})</td>
<td>4.6</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>positive transient</td>
<td>-</td>
<td>4.6</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>negative transient</td>
<td>-</td>
<td>-2.2</td>
<td>-</td>
<td>V</td>
</tr>
</tbody>
</table>

[1] This parameter is guaranteed by design.
PHDMI2F4
ESD protection for ultra high-speed interfaces

Fig 1. Insertion loss; typical values

Fig 2. Relative capacitance as a function of input voltage; typical values

Fig 3. Crosstalk; typical values

Fig 4. Differential Time Domain Reflectometer (TDR) plot; typical values

Sdd21 normalized to 100 Ω; differential pairs CH1/CH2 versus CH3/CH4

\[ a = \frac{C_{line}}{C_{line}(V_i = 0 \text{ V})} \]

\( t_r = 200 \text{ ps}; \) differential pair CH1 + CH2

(1) PHDMI2F4 on reference board

(2) Reference board without device under test (DUT)
Test frequency: 148.5 MHz
Differential swing voltage: 810 mV
Horizontal scale: 34 ps/div

Fig 5. HDMI 2.0 TP1 eye diagram, PCB with PHDMI2F4 (2160p, 60 Hz)

Test frequency: 148.5 MHz
Differential swing voltage: 800 mV
Horizontal scale: 34 ps/div

Fig 6. HDMI 2.0 TP1 eye diagram, PCB without PHDMI2F4 (2160p, 60 Hz, reference)
Test frequency: 148.5 MHz  
Differential swing voltage: 809 mV  
Horizontal scale: 34 ps/div  
**Remark:** Measured at Test Point 2 (TP2) worst cable emulator, reference cable equalizer and worst case positive skew.

**Fig 7.** HDMI 2.0 TP2 eye diagram, PCB with PHDMI2F4 (2160p, 60 Hz)

Test frequency: 148.5 MHz  
Differential swing voltage: 820 mV  
Horizontal scale: 34 ps/div  
**Remark:** Measured at Test Point 2 (TP2) worst cable emulator, reference cable equalizer and worst case positive skew.

**Fig 8.** HDMI 2.0 TP2 eye diagram, PCB without PHDMI2F4 (2160p, 60 Hz, reference)
The device uses an advanced clamping structure showing a negative dynamic resistance. This snap-back behavior strongly reduces the clamping voltage to the system behind the ESD protection during an ESD event. Do not connect unlimited DC current sources to the data lines to avoid keeping the ESD protection device in snap-back state after exceeding breakdown voltage (due to an ESD pulse for instance).
7. Application information

The device is designed to provide high-level ESD protection for high-speed serial data buses such as HDMI 2.0, DisplayPort and LVDS data lines.

When designing the Printed-Circuit Board (PCB), give careful consideration to impedance matching and signal coupling. Do not connect the signal lines to unlimited current sources like, for example, a battery.

A basic application diagram for the ESD protection of an HDMI interface is shown in Figure 13.
8. Package outline

Fig 14. Package outline DFN2510A-10 (SOT1176-1)
9. Soldering

Footprint information for reflow soldering of DFN2510A-10 package

- solder land
- solder paste deposit
- solder land plus solder paste
- occupied area
- solder resist

**Remark:**
- Stencil of 75 μm is recommended.
- A stencil of 75 μm gives an aspect ratio of 0.77
- With a stencil of 100 μm one will obtain an aspect ratio of 0.58

<table>
<thead>
<tr>
<th>P</th>
<th>Ay</th>
<th>By</th>
<th>C</th>
<th>D</th>
<th>Hx</th>
<th>Hy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>1.25</td>
<td>0.3</td>
<td>0.475</td>
<td>0.2</td>
<td>2.45</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**Fig 15. Reflow soldering footprint DFN2510A-10 (SOT1176-1)**
10. Revision history

Table 6. Revision history

<table>
<thead>
<tr>
<th>Document ID</th>
<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHDMI2F4 v.1</td>
<td>20140731</td>
<td>Product data sheet</td>
<td>-</td>
<td>-</td>
</tr>
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11. Legal information

11.1 Data sheet status

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Objective [short] data sheet</td>
<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
</tr>
<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nexperia.com.

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