

**HDMI**

# IP4776CZ38

Fully integrated HDMI interface with level shifter, ESD and backdrive protection

Rev. 6 — 7 January 2011

Product data sheet

## 1. General description

The IP4776CZ38 is designed for HDMI host-interface protection. The IP4776CZ38 includes level shifting for the DDC channels and backdrive protection for HDMI as well as high-level ESD protection diodes for the TMDS signal lines.

The level shifting function is required when the receiver operates at a supply voltage lower than the external devices to protect the I/Os against overvoltages. The IP4776CZ38 contains four N-channel MOSFETs to provide this level shifting function.

Furthermore, all TMDS intra-pairs are protected by a special diode configuration offering an ultra low line capacitance of 0.7 pF only. These diodes provide protection to downstream components from ESD voltages up to  $\pm 8$  kV contact according to the IEC 61000-4-2, level 4 standard.

## 2. Features and benefits

- Pb-free and RoHS compliant, Dark Green
- Integrated high-level ESD protection, level shifting and backdrive protection
- All TMDS lines with integrated rail-to-rail clamping diodes with downstream ESD protection of  $\pm 8$  kV according to IEC 61000-4-2, level 4 standard
- Matched 0.5 mm trace spacing
- Bidirectional level shifting N-channel FETs provided for DDC clock and data channels
- TMDS lines with  $\leq 0.05$  pF matching of capacitance between the TMDS pairs
- Ultra low line capacitance of 0.7 pF per channel
- HDMI 1.3 compliant
- Backdrive protection
- 38-pin TSSOP lead-free package

## 3. Applications

- The IP4776CZ38 is designed for HDMI receiver and transmitter port protection, level shifting and backdrive protection e.g.:
  - ◆ TV
  - ◆ Graphics card
  - ◆ Set-top box
  - ◆ DVD
  - ◆ Digital media adapter
  - ◆ Game console



4. Ordering information

| Table 1. Ordering information |         |                                                                                              |          |
|-------------------------------|---------|----------------------------------------------------------------------------------------------|----------|
| Type number                   | Package |                                                                                              |          |
|                               | Name    | Description                                                                                  | Version  |
| IP4776CZ38                    | TSSOP38 | plastic thin shrink small outline package; 38 leads;<br>body width 4.4 mm; lead pitch 0.5 mm | SOT510-1 |

5. Functional diagram

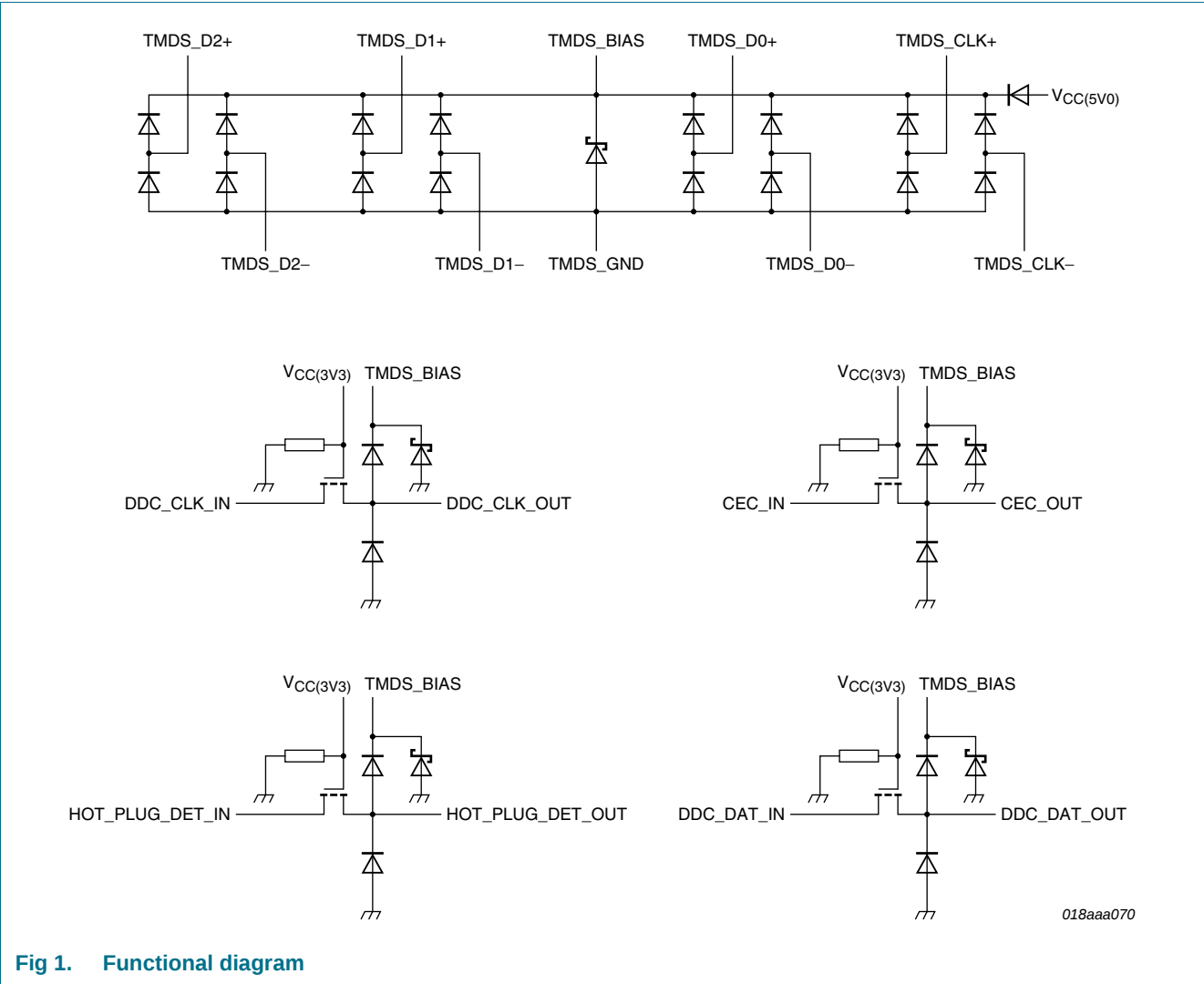
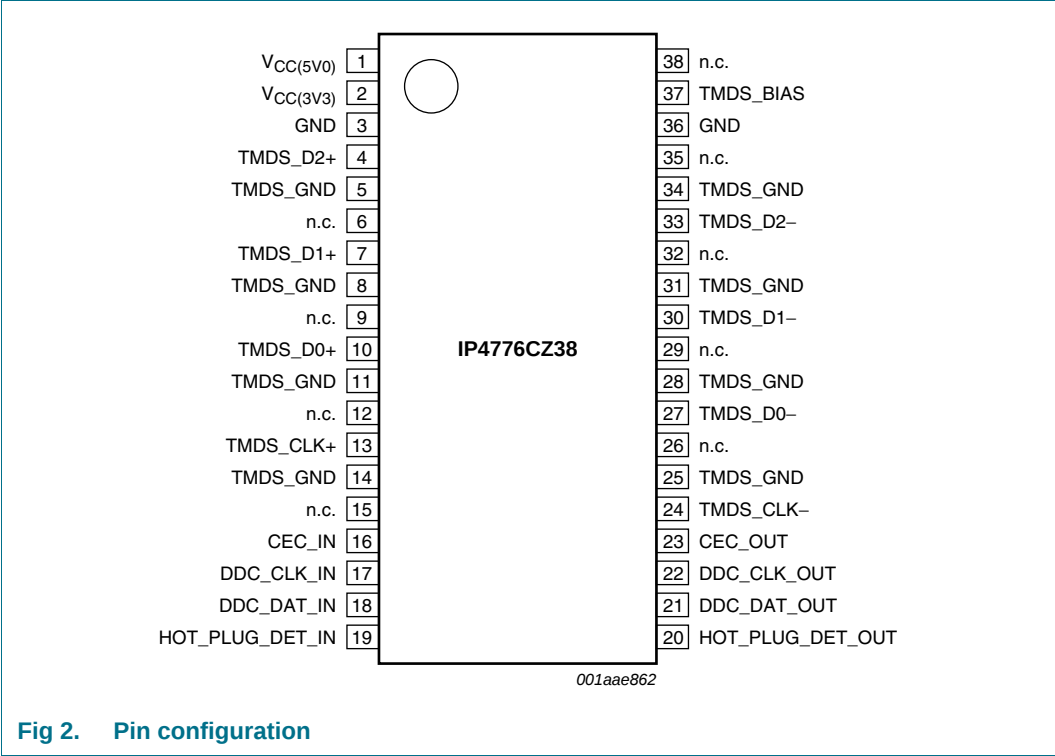


Fig 1. Functional diagram

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

| Symbol                | Pin | Description                                |
|-----------------------|-----|--------------------------------------------|
| V <sub>CC</sub> (5V0) | 1   | supply voltage                             |
| V <sub>CC</sub> (3V3) | 2   | bias supply voltage for the level shifters |
| GND                   | 3   | ground reference <sup>[1]</sup>            |
| TMDS_D2+              | 4   | D2+ TMDS ESD protection <sup>[2]</sup>     |
| TMDS_GND              | 5   | ground reference <sup>[1]</sup>            |
| n.c.                  | 6   | not connected <sup>[2]</sup>               |
| TMDS_D1+              | 7   | D1+ TMDS ESD protection <sup>[2]</sup>     |
| TMDS_GND              | 8   | ground reference <sup>[1]</sup>            |
| n.c.                  | 9   | not connected <sup>[2]</sup>               |
| TMDS_D0+              | 10  | D0+ TMDS ESD protection <sup>[2]</sup>     |
| TMDS_GND              | 11  | ground reference <sup>[1]</sup>            |
| n.c.                  | 12  | not connected <sup>[2]</sup>               |
| TMDS_CLK+             | 13  | CLK+ TMDS ESD protection <sup>[2]</sup>    |
| TMDS_GND              | 14  | ground reference <sup>[1]</sup>            |
| n.c.                  | 15  | not connected <sup>[2]</sup>               |

Table 2. Pin description ...continued

| Symbol           | Pin | Description                                                                                                                           |
|------------------|-----|---------------------------------------------------------------------------------------------------------------------------------------|
| CEC_IN           | 16  | CEC input <sup>[3]</sup>                                                                                                              |
| DDC_CLK_IN       | 17  | DDC clock input <sup>[3]</sup>                                                                                                        |
| DDC_DAT_IN       | 18  | DDC data input <sup>[3]</sup>                                                                                                         |
| HOT_PLUG_DET_IN  | 19  | hot plug detection input <sup>[3]</sup>                                                                                               |
| HOT_PLUG_DET_OUT | 20  | hot plug detection output <sup>[4]</sup>                                                                                              |
| DDC_DAT_OUT      | 21  | DDC data output <sup>[4]</sup>                                                                                                        |
| DDC_CLK_OUT      | 22  | DDC clock output <sup>[4]</sup>                                                                                                       |
| CEC_OUT          | 23  | CEC output <sup>[3]</sup>                                                                                                             |
| TMDS_CLK-        | 24  | CLK- TMDS ESD protection <sup>[2]</sup>                                                                                               |
| TMDS_GND         | 25  | ground reference <sup>[1]</sup>                                                                                                       |
| n.c.             | 26  | not connected <sup>[2]</sup>                                                                                                          |
| TMDS_D0-         | 27  | D0- TMDS ESD protection <sup>[2]</sup>                                                                                                |
| TMDS_GND         | 28  | ground reference <sup>[1]</sup>                                                                                                       |
| n.c.             | 29  | not connected <sup>[2]</sup>                                                                                                          |
| TMDS_D1-         | 30  | D1- TMDS ESD protection <sup>[2]</sup>                                                                                                |
| TMDS_GND         | 31  | ground reference <sup>[1]</sup>                                                                                                       |
| n.c.             | 32  | not connected <sup>[2]</sup>                                                                                                          |
| TMDS_D2-         | 33  | D2- TMDS ESD protection <sup>[2]</sup>                                                                                                |
| TMDS_GND         | 34  | ground reference <sup>[1]</sup>                                                                                                       |
| n.c.             | 35  | not connected <sup>[2]</sup>                                                                                                          |
| GND              | 36  | ground reference <sup>[1]</sup>                                                                                                       |
| TMDS_BIAS        | 37  | bias for TMDS ESD protection and bias for level shifter output ESD protection. This pin must be connected to a 0.1 $\mu$ F capacitor. |
| n.c.             | 38  | not connected                                                                                                                         |

[1] Pins GND and TMDS\_GND are internally connected.

[2] This pin always has to be connected to the pin on the opposite location of the IC via a PCB track to guarantee correct functionality; see [Figure 3](#), [Figure 4](#) and [Figure 5](#).

[3]  $V_{CC(3V3)}$  referenced logic level in.

[4]  $V_{CC(5V0)}$  referenced logic level out.

## 7. Limiting values

**Table 3. Limiting values**

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

| Symbol    | Parameter                       | Conditions                                                 | Min       | Max  | Unit |
|-----------|---------------------------------|------------------------------------------------------------|-----------|------|------|
| $V_{CC}$  | supply voltage                  |                                                            | GND – 0.5 | 5.5  | V    |
| $V_I$     | input voltage                   | at input pins                                              | GND – 0.5 | 5.5  | V    |
| $V_{ESD}$ | electrostatic discharge voltage | signal pins; IEC 61000-4-2, level 4                        | [1]       |      |      |
|           |                                 | contact                                                    | [2] –8    | +8   | kV   |
|           |                                 | air discharge                                              | [2] –15   | +15  | kV   |
|           |                                 | all other pins; MIL-STD-883 Method 3015 (human body model) |           |      |      |
|           |                                 | contact                                                    | –2        | +2   | kV   |
|           |                                 | air discharge                                              | –2        | +2   | kV   |
| $T_{stg}$ | storage temperature             |                                                            | –55       | +125 | °C   |

[1] Signal pins:  
 TMDS\_D2+, TMDS\_D2–, TMDS\_D1+, TMDS\_D1–, TMDS\_D0+, TMDS\_D0–,  
 TMDS\_CLK+, TMDS\_CLK–,  
 CEC\_OUT,  
 DDC\_DAT\_OUT,  
 DDC\_CLK\_OUT,  
 HOT\_PLUG\_DET\_OUT.

[2] This measurement is performed with a 0.1  $\mu$ F external capacitor on pin TMDS\_BIAS.

## 8. Recommended operating conditions

**Table 4. Recommended operating conditions**

| Symbol    | Parameter           | Conditions | Min | Typ | Max | Unit |
|-----------|---------------------|------------|-----|-----|-----|------|
| $T_{amb}$ | ambient temperature |            | –40 | -   | +85 | °C   |

## 9. Characteristics

**Table 5. Characteristics**

$T_{amb} = 25\text{ °C}$ ; unless otherwise specified.

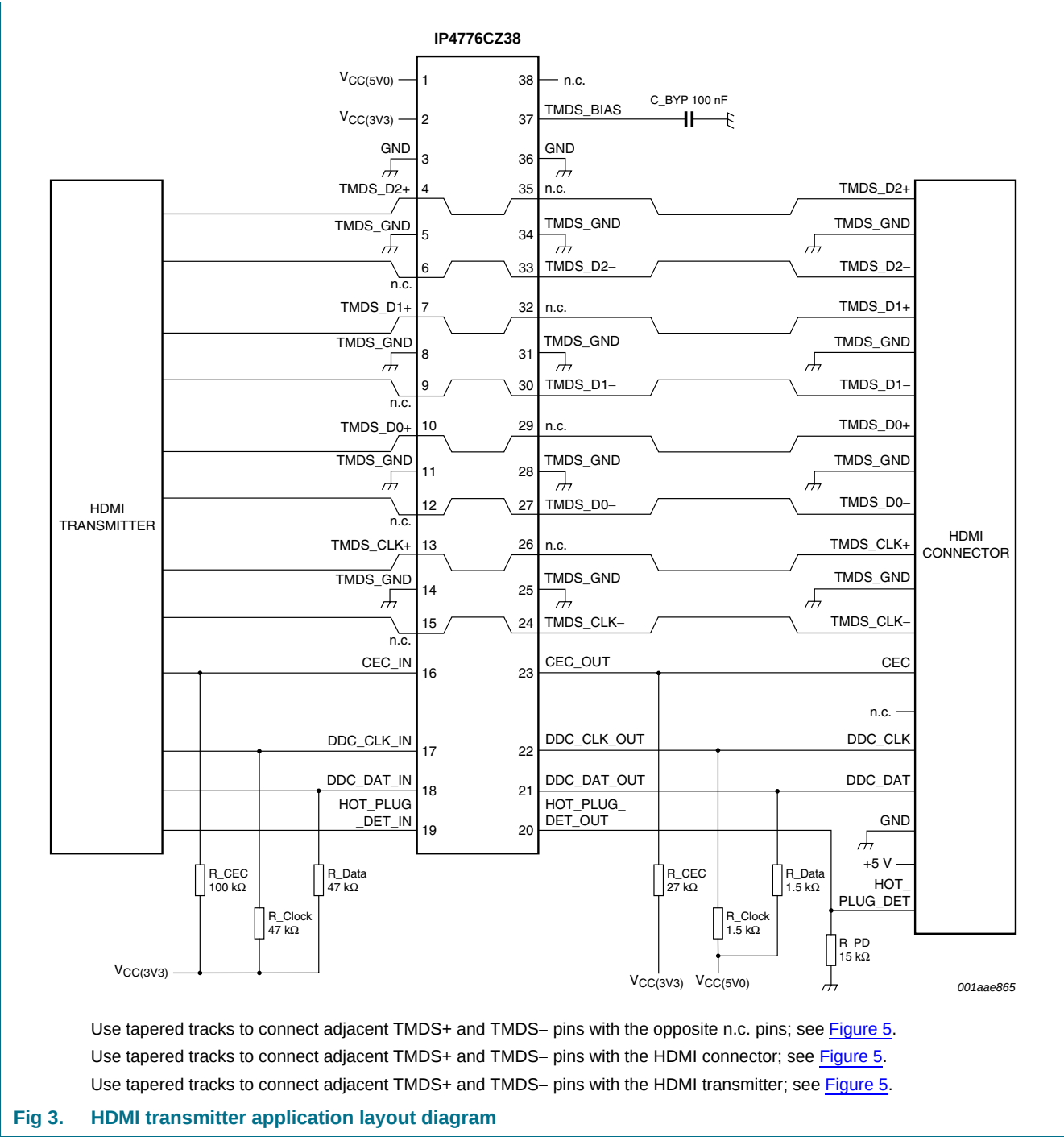
| Symbol                | Parameter                                             | Conditions                                                                  | Min   | Typ | Max | Unit    |
|-----------------------|-------------------------------------------------------|-----------------------------------------------------------------------------|-------|-----|-----|---------|
| $I_{CC(5V0)}$         | supply current (5.0 V)                                | $V_{CC(5V0)} = 5.0\text{ V}$                                                | -     | -   | 130 | $\mu$ A |
| $I_{CC(3V3)}$         | supply current (3.3 V)                                | $V_{CC(3V3)} = 3.3\text{ V}$                                                | -     | 1   | 5   | $\mu$ A |
| $I_{bck(out-VCC5V0)}$ | back current from output / TMDS pins to $V_{CC(5V0)}$ | signal pins; powered down; $V_{CC(5V0)} < V_{O(ch)}$                        | [1] - | 0.1 | 0.5 | $\mu$ A |
| $V_{BRzd}$            | Zener diode breakdown voltage                         | $I = 1\text{ mA}$                                                           | 6     | -   | 9   | V       |
| $I_{L(r)}$            | reverse leakage current                               | per TMDS channel; $V_I = 3.0\text{ V}$                                      | -     | -   | 1   | $\mu$ A |
| $V_F$                 | forward voltage                                       |                                                                             | -     | 0.7 | -   | V       |
| $C_{ch(TMDS)}$        | TMDS channel capacitance                              | $V_{CC(5V0)} = 5\text{ V}$ ; $f = 1\text{ MHz}$ ; $V_{bias} = 2.5\text{ V}$ | [2] - | 0.7 | -   | pF      |

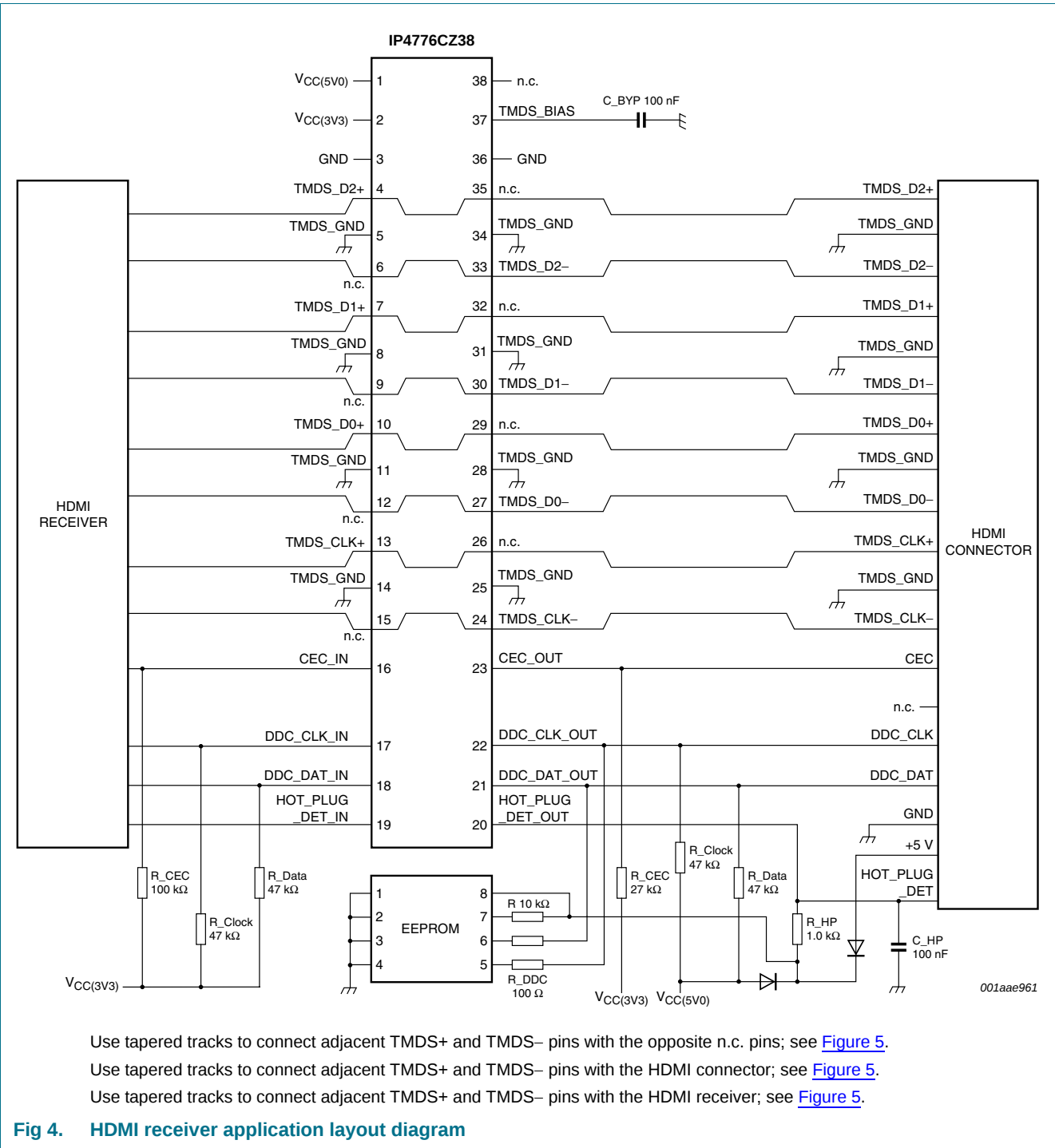
**Table 5.** Characteristics ...continued $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

| Symbol                 | Parameter                                               | Conditions                                                                                                      | Min   | Typ  | Max | Unit     |
|------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------|------|-----|----------|
| $\Delta C_{ch(TMDS)}$  | TMDS channel capacitance difference                     | $V_{CC(5V0)} = 5\text{ V}$ ; $f = 1\text{ MHz}$ ; $V_{bias} = 2.5\text{ V}$                                     | [2] - | 0.05 | -   | pF       |
| $C_{ch(mutual)}$       | mutual channel capacitance                              | between signal pin and pin n.c.;<br>$V_{CC(5V0)} = 0\text{ V}$ ; $f = 1\text{ MHz}$ ; $V_{bias} = 2.5\text{ V}$ | [2] - | 0.07 | -   | pF       |
| $C_{l(ch-GND)(levsh)}$ | level shifting input capacitance from channel to ground | $V_{CC(5V0)} = 0\text{ V}$ ; $f = 1\text{ MHz}$ ; $V_{bias} = 2.5\text{ V}$                                     | [2] - | 4    | 6   | pF       |
| $R_{dyn}$              | dynamic resistance                                      | $I = 1\text{ A}$ ; IEC 61000-4-5/9                                                                              |       |      |     |          |
|                        |                                                         | positive transient                                                                                              | -     | 2.4  | -   | $\Omega$ |
|                        |                                                         | negative transient                                                                                              | -     | 1.3  | -   | $\Omega$ |
| $V_{CL(ch)trt(pos)}$   | positive transient channel clamping voltage             | $V_{ESD} = 8\text{ kV}$                                                                                         | [3] - | 8    | -   | V        |
| $\Delta V_{on}$        | on-state voltage drop                                   | $V_{CC(3V3)} = 2.5\text{ V}$ ; $V_S = \text{GND}$ ; $I_{DS} = 3\text{ mA}$                                      | [4] - | 85   | 140 | mV       |

- [1] Signal pins:  
 TMDS\_D2+, TMDS\_D2-, TMDS\_D1+, TMDS\_D1-, TMDS\_D0+, TMDS\_D0-,  
 TMDS\_CLK+, TMDS\_CLK-,  
 CEC\_OUT,  
 DDC\_DAT\_OUT,  
 DDC\_CLK\_OUT,  
 HOT\_PLUG\_DET\_OUT.
- [2] This parameter is guaranteed by design.
- [3] This measurement is performed with a 0.1  $\mu\text{F}$  external capacitor on pin TMDS\_BIAS.
- [4] For level shifting N-FET.

10. Application information





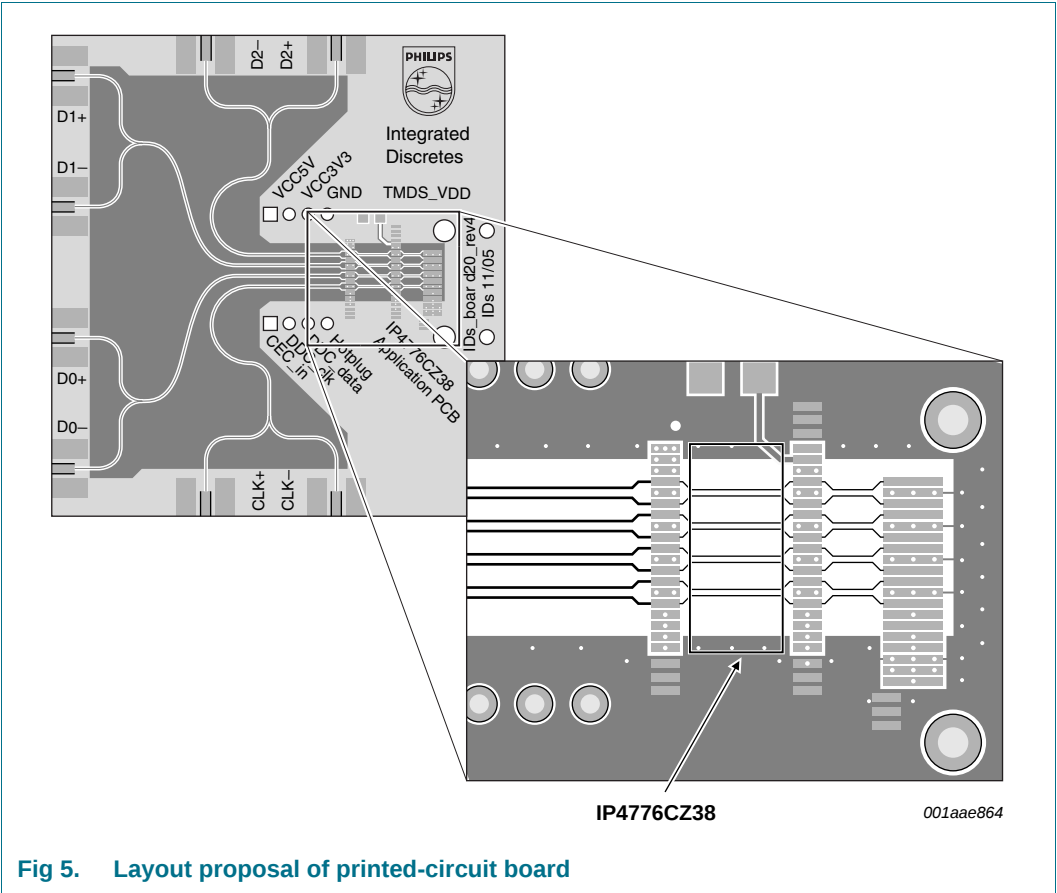


Fig 5. Layout proposal of printed-circuit board

11. Package outline

TSSOP38: plastic thin shrink small outline package; 38 leads; body width 4.4 mm;  
lead pitch 0.5 mm

SOT510-1

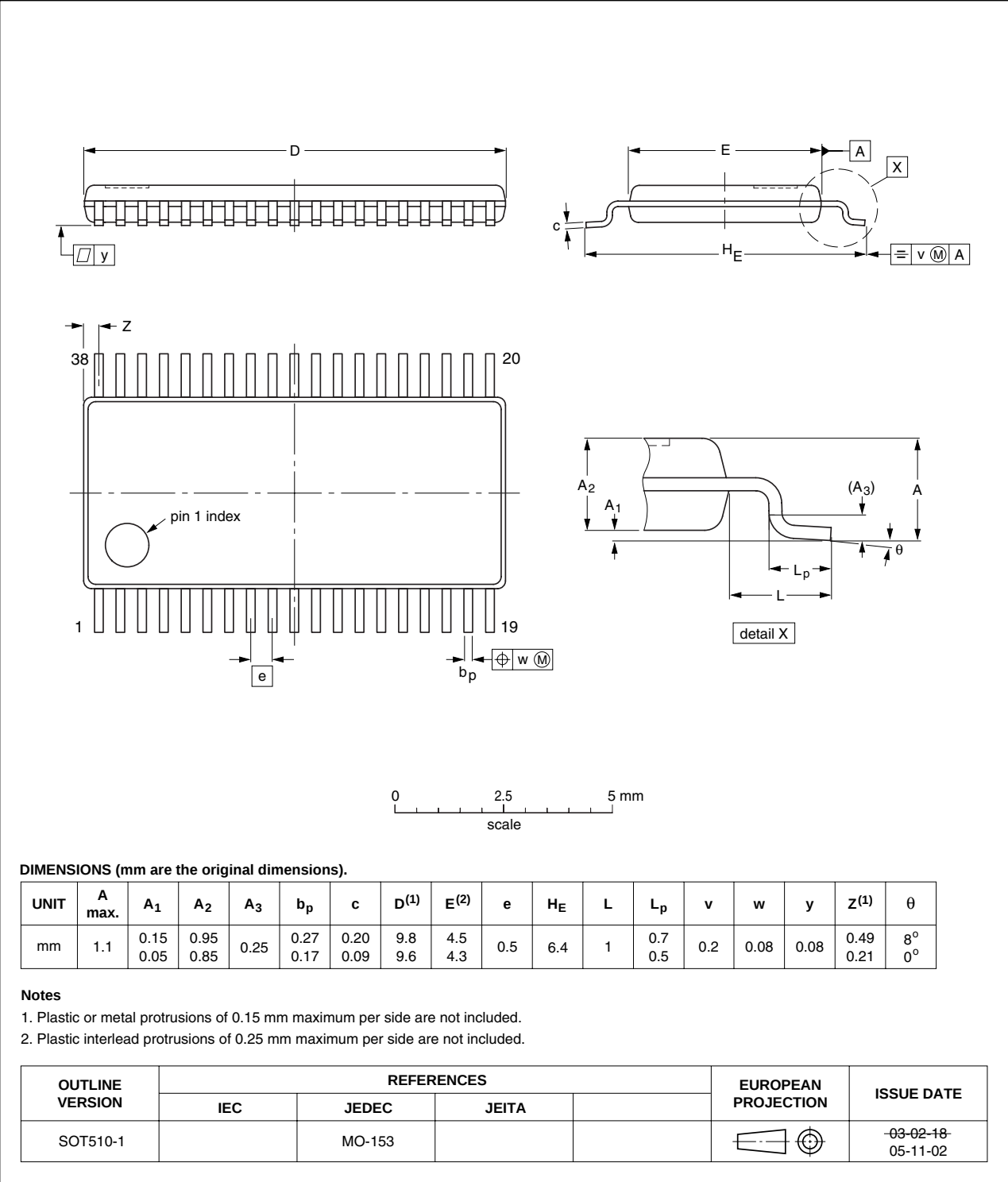


Fig 6. Package outline SOT510-1 (TSSOP38)

## 12. Abbreviations

Table 6. Abbreviations

| Acronym | Description                                            |
|---------|--------------------------------------------------------|
| CEC     | Consumer Electronics Control                           |
| DDC     | Data Display Channel                                   |
| DVD     | Digital Video Disk                                     |
| ESD     | ElectroStatic Discharge                                |
| FET     | Field Effect Transistor                                |
| HDM     | High-Definition Multimedia                             |
| HDMI    | High-Definition Multimedia Interface                   |
| MOSFET  | Metal Oxide Semiconductor Field Effect Transistor      |
| PCB     | Printed-Circuit Board                                  |
| RoHS    | Restriction of the use of certain Hazardous Substances |
| TMDS    | Transition Minimized Differential Signaling            |

## 13. Revision history

Table 7. Revision history

| Document ID    | Release date                           | Data sheet status  | Change notice | Supersedes     |
|----------------|----------------------------------------|--------------------|---------------|----------------|
| IP4776CZ38 v.6 | 20110107                               | Product data sheet | -             | IP4776CZ38 v.5 |
| Modifications: | • <a href="#">Figure 1</a> : corrected |                    |               |                |
| IP4776CZ38 v.5 | 20100706                               | Product data sheet | -             | IP4776CZ38 v.4 |
| IP4776CZ38 v.4 | 20070612                               | Product data sheet | -             | IP4776CZ38 v.3 |
| IP4776CZ38 v.3 | 20070125                               | Product data sheet | -             | IP4776CZ38 v.2 |
| IP4776CZ38 v.2 | 20060918                               | Product data sheet | -             | IP4776CZ38 v.1 |
| IP4776CZ38 v.1 | 20060714                               | Product data sheet | -             | -              |

## 14. Legal information

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| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|-----------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
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Date of release: 7 January 2011

Document identifier: IP4776CZ38