

**HDMI Switch ICs**

# 1 for input 1 output buffer with Termination sense correspondence (Sync with HPD\_SINK)

**BU16024KV****●Description**

BU16024KV is 1 for input 1 output HDMI/DVI buffer LSI. Each port supports 2.25Gbps. (HDMI 1.3a).

This device control is simple. It requires only 3.3V and a few GPIO controls.

Terminated resistors(50Ω) are integrated at each input port. When HPD\_SINK is L, termination resistors are turned off.

TMDs inputs are high impedance.

This device is integrated equalization function and DDC buffer function, so It can adapt long cable.

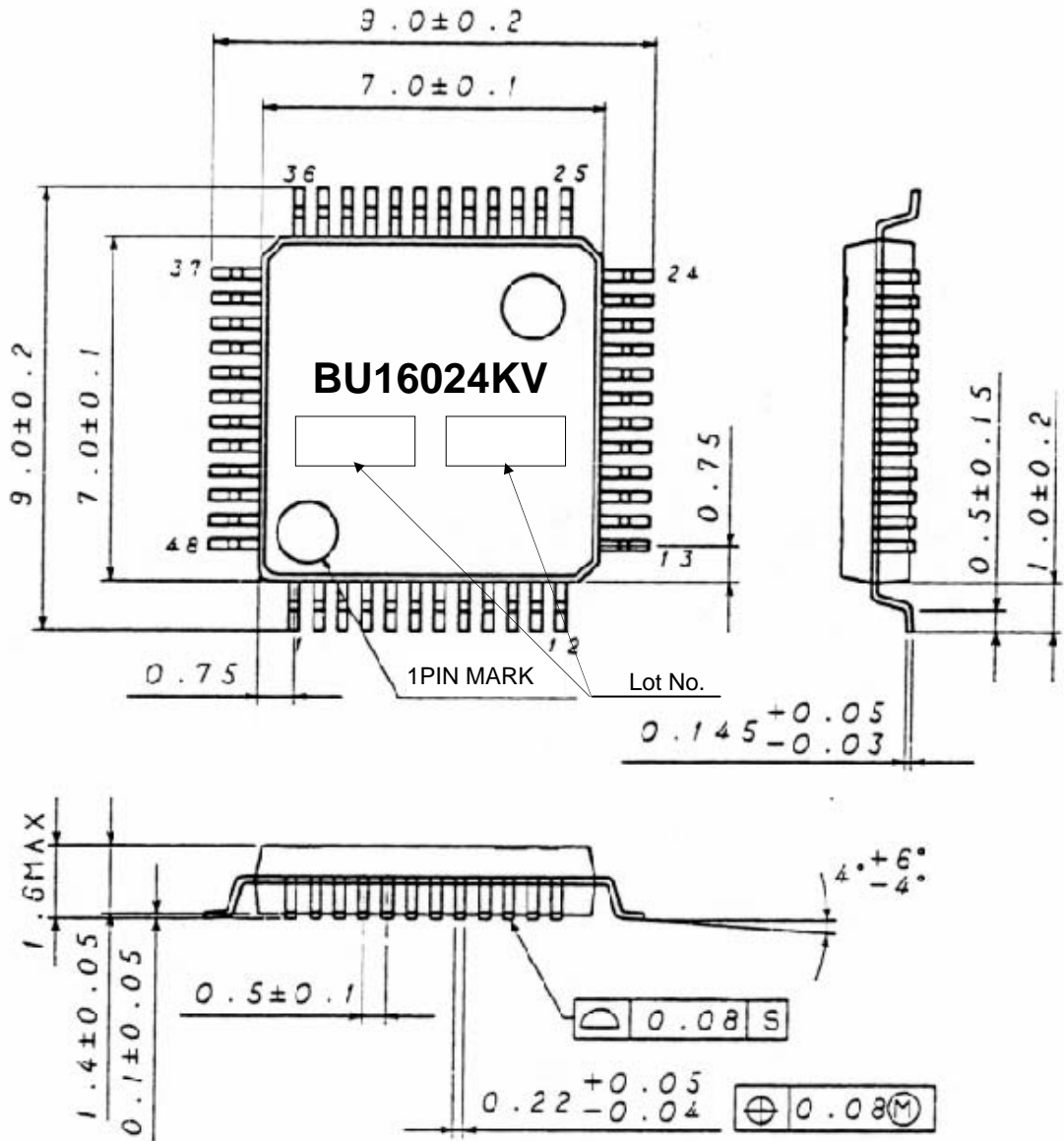
**●Features**

- Supports 2.25 Gbps signaling rate for 480i/p, 720i/p, and 1080i/p resolution to 12-bit color depth
- Compatible with HDMI 1.3a
- 5V tolerance to all DDC and HPD\_SINK inputs
- Integrated DDC buffer
- Integrated switchable 50Ω receiver termination
- Integrated equalizer circuit to adapt long cable
- Selectable output De-Emphasis Supports
- High Impedance outputs when disabled
- HBM ESD protection exceed 10kV
- 3.3-V supply operation
- 48-Pin VQFP package
- ROHS compatible

**●Applications**

- Digital TV
- DVD Player
- Set-Top-Box
- Audio Video Receiver
- Digital Projector
- DVI or HDMI Switch Box
- PC

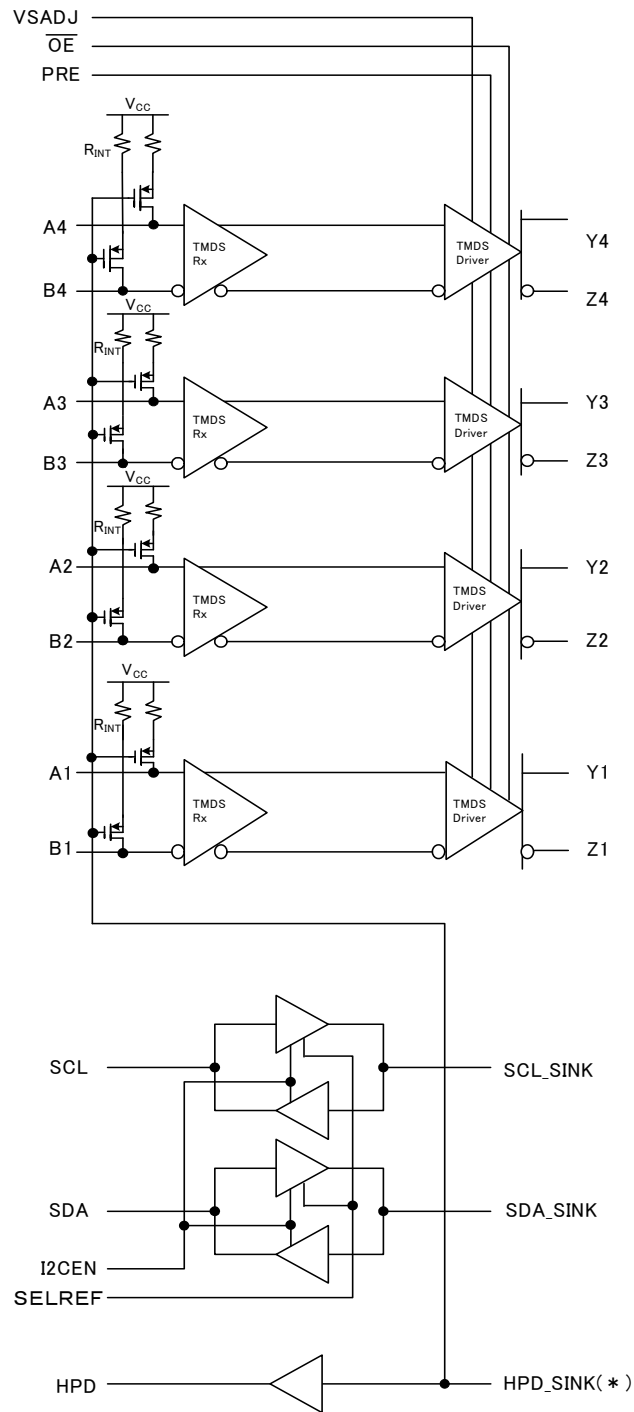
●OUTSIDE DIMENSION CHART



(UNIT : mm)

**Fig. 1-1 . Outside dimension chart**

●BLOCK DIAGRAM

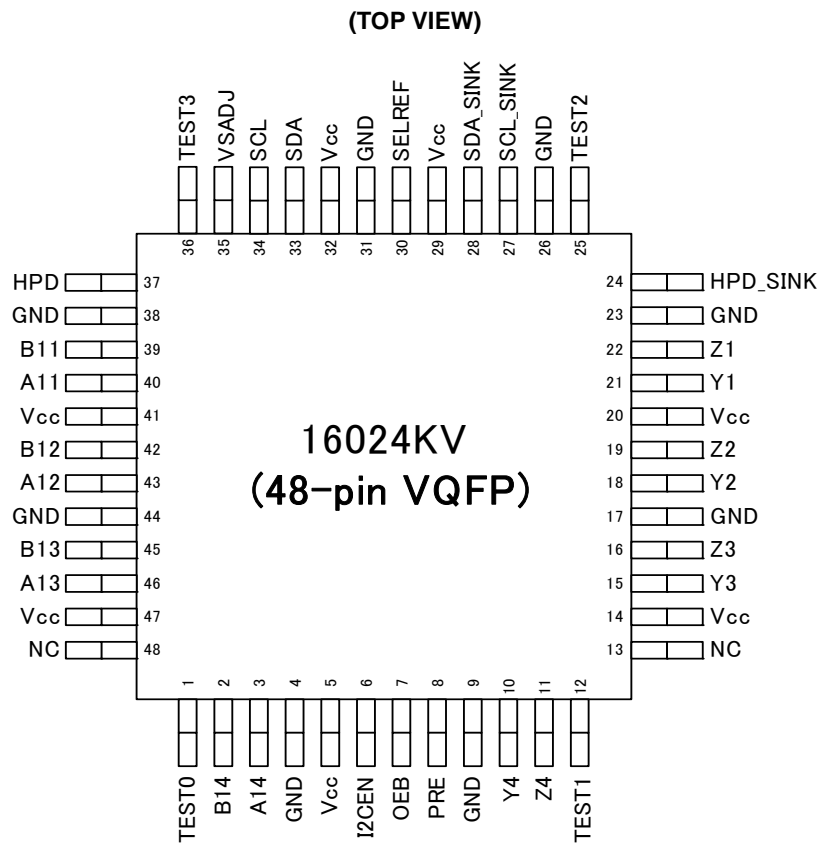


(\*) when HPD\_SINK = "L". Termination resistor is turned off.

**Fig. 2-1. Block Diagram**

● PIN EXPLANATION

1). PIN ASSIGNMENT

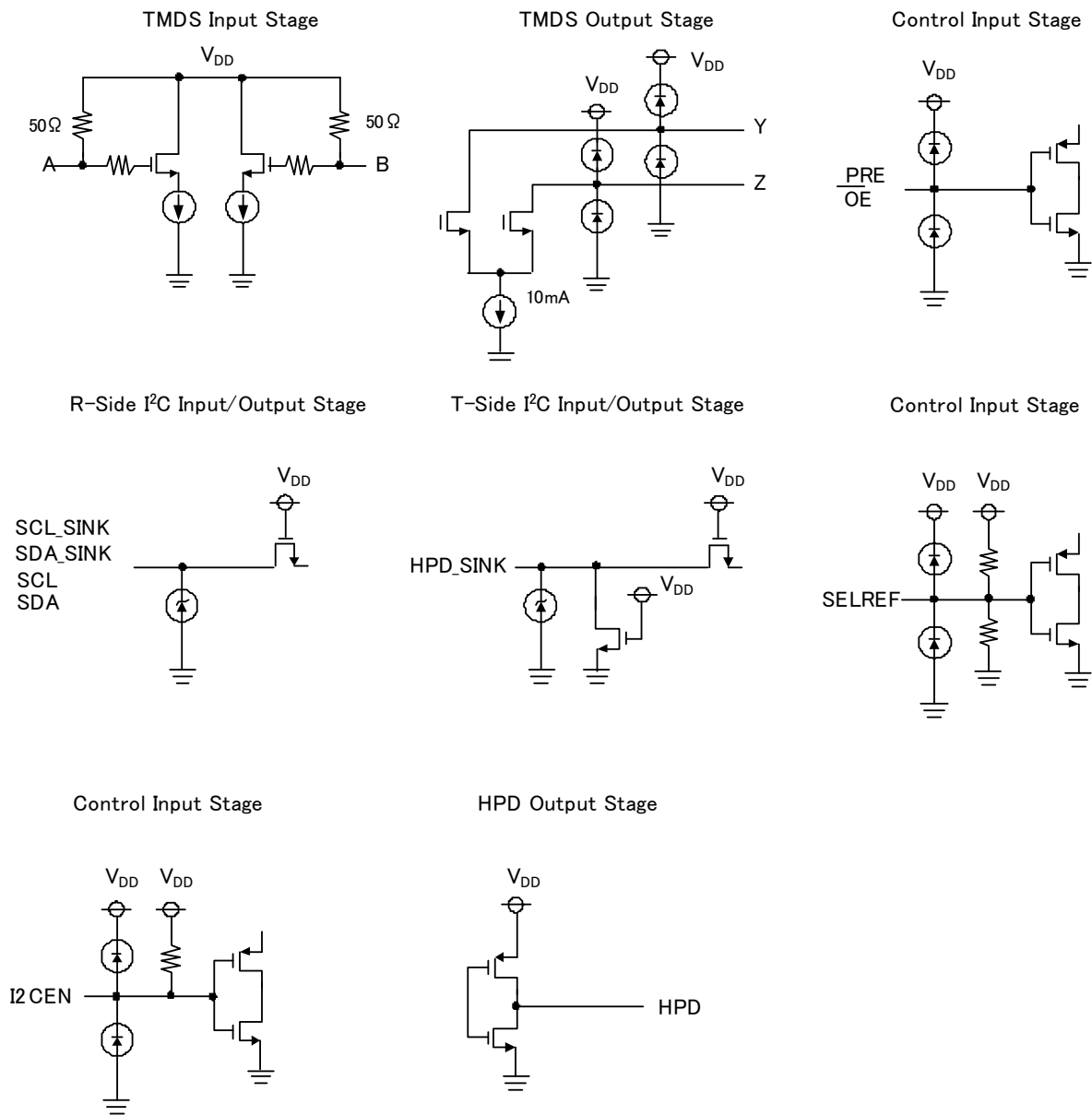


**Fig3-1. Pin Location**

## 2). PIN LIST

| TERMINAL           |                                 | I/O | DESCRIPTION   |
|--------------------|---------------------------------|-----|---|
| NAME               | No.                             |     |   |
| B1, B2, B3, B4     | 39, 42, 45, 2                   | I   | TMDS Negative inputs  |
| A1, A2, A3, A4     | 40, 43, 46, 3                   | I   | TMDS Positive inputs  |
| Z1, Z2, Z3, Z4     | 22, 19, 16, 11                  | O   | TMDS Negative outputs   |
| Y1, Y2, Y3, Y4     | 21, 18, 15, 10                  | O   | TMDS Positive outputs   |
| HPD                | 37                              | O   | Hot plug detector output  |
| HPD_SINK           | 24                              | I   | Hot plug detector input   |
| SCL                | 34                              | I/O | DDC Bus clock line to source                                    |
| SDA                | 33                              | I/O | DDC Bus data line to source                                     |
| SCL_SINK           | 27                              | I/O | DDC Bus clock line to sink                                      |
| SDA_SINK           | 28                              | I/O | DDC Bus data line to sink                                       |
| VSADJ              | 35                              | I   | TMDS Compliant voltage swing control(via 4.64k $\Omega$ to GND) |
| I <sup>2</sup> CEN | 6                               | I   | I <sup>2</sup> C Repeater enable<br>Low : High-Z High : Active  |
| SELREF             | 30                              | I   | SCL_SINK/SDA_SINK Output voltage select                         |
| TEST0, 1, 2, 3     | 1, 12, 25, 36                   | I   | Open or GND connect (recommend)                                 |
| N.C                | 13, 48                          |     | Open or GND connect (recommend)                                 |
| OEB                | 7                               | I   | TMDS Output enable<br>Low : Active High : High-Z                |
| PRE                | 8                               | I   | TMDS Output de-emphasis adjustment<br>Low : OFF High : ON       |
| V <sub>CC</sub>    | 5, 14, 20, 29,<br>32, 41, 47    | -   | Power supply  |
| GND                | 4, 9, 17, 23, 26,<br>31, 38, 44 | -   | Ground  |

●EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



**Fig4-1 I/O pin schematic diagram**

● ELECTRICAL SPECIFICATIONS

1.) ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

| ITEM   | MIN. | TYP. | MAX.    | UNIT |
|--|------|------|---------|------|
| Supply voltage (V <sub>CC</sub> )                    | -0.3 | -    | 4.0     | V    |
| SCL, SCL_SINK, SDA, SDA_SINK, HPD_SINK input voltage | -0.3 | -    | 6.0     | V    |
| Differential input voltage                           | 2.5  | -    | 4       | V    |
| PRE, I <sup>2</sup> CEN, SELREF, OEB input voltage   | -0.3 | -    | 4       | V    |
| Power dissipation                                    | -    | -    | 1200 ※1 | mW   |
| Storage temperature range                            | -55  | -    | 125     | °C   |

※70mm×70mm×1.6mm glass epoxy board mount. (Reverse Cu occupation rate: 15mm×15mm)

When it's used by than Ta=25°C, it's reduced by 12mW/°C.

2.) RECOMMENDED OPERATING CONDITIONS

| SYMBOL   | PARAMETER  | MIN.                 | TYP. | MAX.                  | UNIT  |
|--|--|----------------------|------|-----------------------|-------|
| V <sub>CC</sub>                                    | Supply voltage                                   | 3.0                  | 3.3  | 3.6                   | V     |
| T <sub>A</sub>                                     | Operating free-air temperature                   | 0                    | -    | 70                    | °C    |
| <b>TMDS DIFFERENTIAL PINS (A/B)</b>                |  |                      |      |                       |       |
| V <sub>ID</sub>                                    | Receiver peak-to-peak differential input voltage | 150                  | -    | 1560                  | mVp-p |
| V <sub>IC</sub>                                    | Input common mode voltage                        | V <sub>CC</sub> -0.6 | -    | V <sub>CC</sub> +0.01 | V     |
| R <sub>VSADJ</sub>                                 | Resistor for TMDS compliant voltage swing range  | 4.6                  | 4.64 | 4.68                  | kΩ    |
| AV <sub>CC</sub>                                   | TMDS output termination voltage, see Figure 5-1  | 3                    | 3.3  | 3.6                   | V     |
| R <sub>T</sub>                                     | Termination resistance, see Figure 5-1           | 45                   | 50   | 55                    | Ω     |
| Signaling rate                                     |  | 0                    | -    | 2.25                  | Gbps  |
| <b>CONTROL PINS (PRE, I<sup>2</sup>CEN, OEB)</b>   |  |                      |      |                       |       |
| V <sub>IH</sub>                                    | LVTTL High-level input voltage                   | 2                    | -    | V <sub>CC</sub>       | V     |
| V <sub>IL</sub>                                    | LVTTL Low-level input voltage                    | GND                  | -    | 0.8                   | V     |
| <b>CONTROL PINS (SELREF)</b>                       |  |                      |      |                       |       |
| V <sub>IH</sub>                                    | High-level input voltage                         | 0.9V <sub>CC</sub>   | -    | V <sub>CC</sub>       | V     |
| V <sub>IL</sub>                                    | Low-level input voltage                          | GND                  | -    | 0.1V <sub>CC</sub>    | V     |
| <b>DDC I/O PINS (SCL, SCL_SINK, SDA, SDA_SINK)</b> |  |                      |      |                       |       |
| <b>Tx (SDA_SINK, SCL_SINK)</b>                     |  |                      |      |                       |       |
| V <sub>IH</sub>                                    | High-level input voltage                         | 2.1                  | -    | 5.5                   | V     |
| V <sub>IL</sub>                                    | Low-level input voltage                          | -0.3                 | -    | 0.35                  | V     |
| <b>Rx (SDA, SCL)</b>                               |  |                      |      |                       |       |
| V <sub>IH</sub>                                    | High-level input voltage                         | 2.4                  | -    | 5.5                   | V     |
| V <sub>IL</sub>                                    | Low-level input voltage                          | -0.3                 | -    | 0.8                   | V     |
| <b>STATUS (HPD_SINK)</b>                           |  |                      |      |                       |       |
| V <sub>IH</sub>                                    | High-level input voltage                         | 2.4                  | -    | 5.5                   | V     |
| V <sub>IL</sub>                                    | Low-level input voltage                          | GND                  | -    | 0.8                   | V     |

### 3.) ELECTRICAL CHARACTERISTICS

Over recommended operating conditions (unless otherwise noted)

| SYMBOL                                   | PARAMETER  | TEST CONDITIONS   | LIMITS                 |                     |                        | UNIT                 |
|--|--|---|------------------------|---------------------|------------------------|----------------------|
|  |  |   | MIN.                   | TYP. <sup>(1)</sup> | MAX.                   |                      |
| I <sub>CC</sub>                          | Supply current   | V <sub>IH</sub> = V <sub>CC</sub> , V <sub>IL</sub> = V <sub>CC</sub> -0.4V, R <sub>VSADJ</sub> = 4.64kΩ<br>R <sub>T</sub> = 50Ω, AV <sub>CC</sub> = 3.3V<br>Am/Bm = 2.25 Gbps HDMI data pattern,<br>m = 2,3,4<br>A1/B1 = 225 MHz clock | -                      | 140                 | 170                    | mA                   |
| P <sub>D</sub>                           | Power dissipation  | V <sub>IH</sub> = V <sub>CC</sub> , V <sub>IL</sub> = V <sub>CC</sub> -0.4V, R <sub>VSADJ</sub> = 4.64kΩ<br>R <sub>T</sub> = 50Ω, AV <sub>CC</sub> = 3.3V<br>Am/Bm = 2.25Gbps HDMI data pattern,<br>m = 2,3,4<br>A1/B1 = 225 MHz clock  | -                      | 480                 | 700                    | mW                   |
| <b>TMDS DIFFERENTIAL PINS (A/B; Y/Z)</b> |  |   |                        |                     |                        |                      |
| V <sub>OH</sub>                          | Single-ended high-level output voltage                                 | AV <sub>CC</sub> = 3.3V,<br>R <sub>T</sub> = 50Ω, PRE = 0V  | AV <sub>CC</sub> - 10  | -                   | AV <sub>CC</sub> + 10  | mV                   |
| V <sub>OL</sub>                          | Single-ended low-level output voltage                                  |   | AV <sub>CC</sub> - 600 | -                   | AV <sub>CC</sub> - 400 | mV                   |
| V <sub>SWING</sub>                       | Single-ended low-level swing voltage                                   |   | 400                    | -                   | 600                    | mV                   |
| V <sub>OD(O)</sub>                       | Overshoot of output differential voltage                               |   | -                      | 6%                  | 15%                    | 2xV <sub>swing</sub> |
| V <sub>OD(U)</sub>                       | Undershoot of output differential voltage                              |   | -                      | 12%                 | 25%                    | 2xV <sub>swing</sub> |
| V <sub>OD(pp)</sub>                      | Steady state output differential voltage with de-emphasis              | PRE = V <sub>CC</sub><br>Am/Bm = 225 Mbps HDMI data pattern,<br>m = 2,3,4<br>A1/B1 = 225 MHz clock  | 600                    | -                   | 920                    | mVp-p                |
| R <sub>INT</sub>                         | Input termination resistance   | V <sub>IN</sub> = 2.9V  | 45                     | 50                  | 55                     | Ω                    |
| ΔV <sub>OC(SS)</sub>                     | Change in steady-state common-mode output voltage between logic states |   | -                      | 5                   | -                      | mV                   |



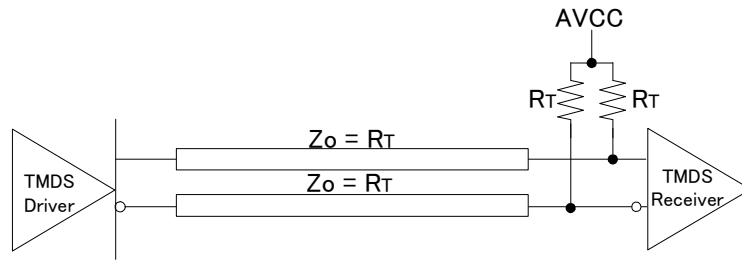
| SYMBOL   | PARAMETER  | TEST CONDITIONS                   | LIMITS                   |                     |                 | UNIT |    |
|--|--|-----------------------------------|--------------------------|---------------------|-----------------|------|----|
|  |  |                                   | MIN.                     | TYP. <sup>(1)</sup> | MAX             |      |    |
| <b>DDC Input and output</b>                    |  |                                   |                          |                     |                 |      |    |
| <b>Tx (SDA_SINK , SCL_SINK )</b>               |  |                                   |                          |                     |                 |      |    |
| I <sub>IKR①</sub>                              | Input leak current,                                    | V <sub>I</sub> = 5.5V             | -10                      | -                   | 10              | uA   |    |
| I <sub>IKR②</sub>                              | Input leak current,                                    | V <sub>I</sub> = V <sub>CC</sub>  | -10                      | -                   | 10              | uA   |    |
| I <sub>OHT</sub>                               | High-level output current                              | V <sub>O</sub> = 3.6V             | -10                      | -                   | 10              | uA   |    |
| I <sub>ILT</sub>                               | Low-level input current                                | V <sub>IL</sub> = GND             | -10                      | -                   | 10              | uA   |    |
| V <sub>OVT</sub>                               | Low-level output voltage                               | R <sub>L</sub> = 4.7kΩ            | SELREF = NC              | 0.43                | -               | 0.57 | V  |
|  |  |                                   | SELREF = GND             | 0.58                | -               | 0.72 |    |
|  |  |                                   | SELREF = V <sub>CC</sub> | 0.73                | -               | 0.87 |    |
| V <sub>OVT</sub> - V <sub>IL</sub>             | Low-level input voltage below output low-level voltage |                                   | SELREF = NC              | -                   | 100             | -    | mV |
|  |  |                                   | SELREF = GND             | -                   | 250             | -    |    |
|  |  |                                   | SELREF = V <sub>CC</sub> | -                   | 400             | -    |    |
| <b>Rx (SDA, SCL)</b>                           |  |                                   |                          |                     |                 |      |    |
| I <sub>IKR①</sub>                              | Input leak current                                     | V <sub>I</sub> = 5.5V             | -10                      | -                   | 10              | uA   |    |
| I <sub>IKR②</sub>                              | Input leak current                                     | V <sub>I</sub> = V <sub>CC</sub>  | -10                      | -                   | 10              | uA   |    |
| I <sub>OHR</sub>                               | High-level output current                              | V <sub>O</sub> = 3.6V             | -10                      | -                   | 10              | uA   |    |
| I <sub>ILR</sub>                               | Low-level input current                                | V <sub>IL</sub> = GND             | -10                      | -                   | 10              | uA   |    |
| V <sub>OLR</sub>                               | Low-level output voltage                               | I <sub>OUT</sub> = 4mA            | -                        | -                   | 0.2             | V    |    |
| <b>STATUS PINS (HPD)</b>                       |  |                                   |                          |                     |                 |      |    |
| V <sub>OH(TTL)</sub>                           | TTL High-level output voltage                          | I <sub>OH</sub> = -8mA            | 2.4                      | -                   | V <sub>CC</sub> | V    |    |
| V <sub>OL(TTL)</sub>                           | TTL Low-level output voltage                           | I <sub>OL</sub> = 8mA             | 0                        | -                   | 0.4             | V    |    |
| <b>CONTROL PINS (PRE, OEB)</b>                 |  |                                   |                          |                     |                 |      |    |
| I <sub>IH</sub>                                | High-level digital input current                       | V <sub>IH</sub> = V <sub>CC</sub> | -10                      | -                   | 10              | uA   |    |
| I <sub>IL</sub>                                | Low-level digital input current                        | V <sub>IL</sub> = GND             | -10                      | -                   | 10              | uA   |    |
| <b>CONTROL PINS (I<sup>2</sup>CEN, SELREF)</b> |  |                                   |                          |                     |                 |      |    |
| I <sub>IH</sub>                                | High-level digital input current                       | V <sub>IH</sub> = V <sub>CC</sub> | -45                      | -                   | 45              | uA   |    |
| I <sub>IL</sub>                                | Low-level digital input current                        | V <sub>IL</sub> = GND             | -45                      | -                   | 45              | uA   |    |
| <b>STATUS PINS (HPD_SINK)</b>                  |  |                                   |                          |                     |                 |      |    |
| I <sub>IH</sub>                                | High-level digital input current                       | V <sub>IH</sub> = 5.5V            | 10                       | 50                  | 100             | uA   |    |
|  |  | V <sub>IH</sub> = V <sub>CC</sub> | 5                        | 30                  | 80              | uA   |    |
| I <sub>IL</sub>                                | Low-level digital input current                        | V <sub>IL</sub> = GND             | -10                      | -                   | 10              | uA   |    |

| SYMBOL   | PARAMETER   | TEST CONDITIONS   | LIMITS |                     |      | UNIT |
|--|---|---|--------|---------------------|------|------|
|  |   |   | MIN.   | TYP. <sup>(1)</sup> | MAX. |      |
| <b>TMDS DIFFERENTIAL PINS (Y/Z)</b>                |   |   |        |                     |      |      |
| t <sub>PLH</sub>                                   | Propagation delay time low-high-level output                          | See Figure5-2, AV <sub>CC</sub> = 3.3V, R <sub>T</sub> = 50Ω, PRE = "H" | -      | 320                 | -    | ps   |
| t <sub>PHL</sub>                                   | Propagation delay time high-low-level output                          |   | -      | 335                 | -    | ps   |
| t <sub>r</sub>                                     | Differential output signal rise time (20%-80%)                        |   | -      | 120                 | -    | ps   |
| t <sub>f</sub>                                     | Differential output signal fall time (20%-80%)                        |   | -      | 120                 | -    | ps   |
| t <sub>sk(p)</sub>                                 | Pulse skew ( t <sub>PHL</sub> - t <sub>PLH</sub>  )                   |   | -      | 15                  | -    | ps   |
| t <sub>sk(D)</sub>                                 | Intra-pair differential skew, see Figure5-3                           |   | -      | 25                  | -    | ps   |
| <b>DDC I/O PINS (SCL, SCL_SINK, SDA, SDA_SINK)</b> |   |   |        |                     |      |      |
| t <sub>pdLHTR</sub> (DDC)                          | Propagation delay time, low-to-high-level output Tx to Rx             | R <sub>L</sub> = 4.7KΩ C <sub>L</sub> = 100pF                           | -      | 650                 | -    | ns   |
| t <sub>pdHLTR</sub> (DDC)                          | Propagation delay time, high-to-low-level output Tx to Rx             |   | -      | 200                 | -    | ns   |
| t <sub>pdLHRT</sub> (DDC)                          | Propagation delay time, low-to-high-level output Rx to Tx             | R <sub>L</sub> = 1.67KΩ C <sub>L</sub> = 400pF                          | -      | 500                 | -    | ns   |
| t <sub>pdHLRT</sub> (DDC)                          | Propagation delay time, high-to-low-level output Rx to Tx             |   | -      | 350                 | -    | ns   |
| tr TX(DDC)   | Tx output Rise time   | R <sub>L</sub> = 4.7KΩ C <sub>L</sub> = 100pF                           | -      | 800                 | -    | ns   |
| tf TX(DDC)   | Tx output Fall time   |   | -      | 150                 | -    | ns   |
| tr RX(DDC)   | Rx output Rise time   | C <sub>L</sub> =10pF  | -      | 950                 | -    | ns   |
| tf RX(DDC)   | Rx output Fall time   |   | -      | 50                  | -    | ns   |
| <b>STATUS PINS(HPD)</b>                            |   |   |        |                     |      |      |
| t <sub>pdLH(HPD)</sub>                             | Propagation delay time, low-to-high-level output from HPD_SINK to HPD | C <sub>L</sub> =10pF  | -      | 5                   | -    | ns   |
| t <sub>pdHL(HPD)</sub>                             | Propagation delay time, high-to-low-level output from HPD_SINK to HPD | C <sub>L</sub> =10pF  | -      | 5                   | -    | ns   |
| t <sub>sx(HPD)</sub>                               | Switch time from port select to the latest valid status of HPD        | C <sub>L</sub> =10pF  | -      | 8                   | -    | ns   |

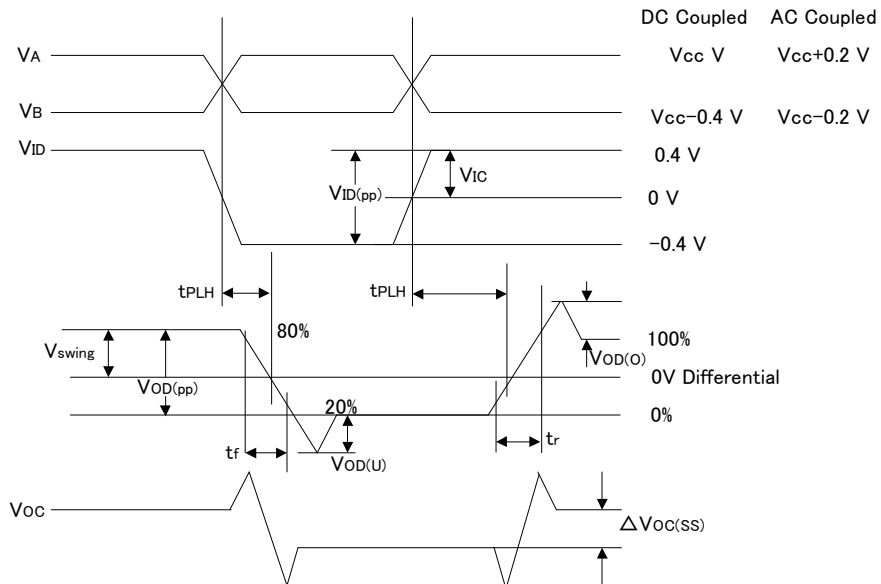
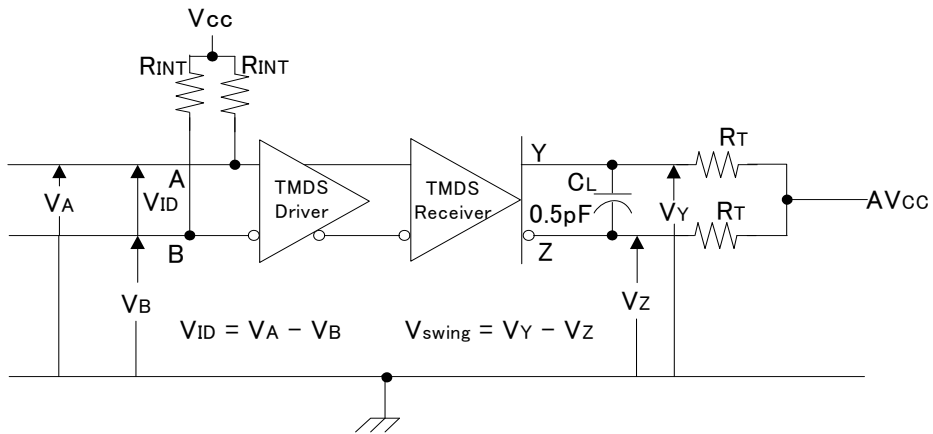
Note:

All typical values are at 25°C and with a 3.3V supply.

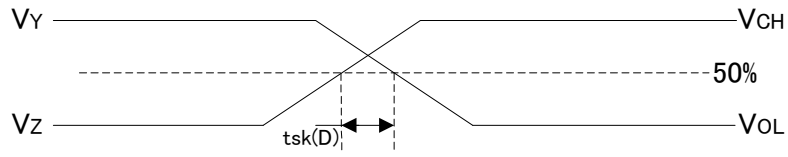
● MEASUREMENT SYMBOL AND CIRCUIT



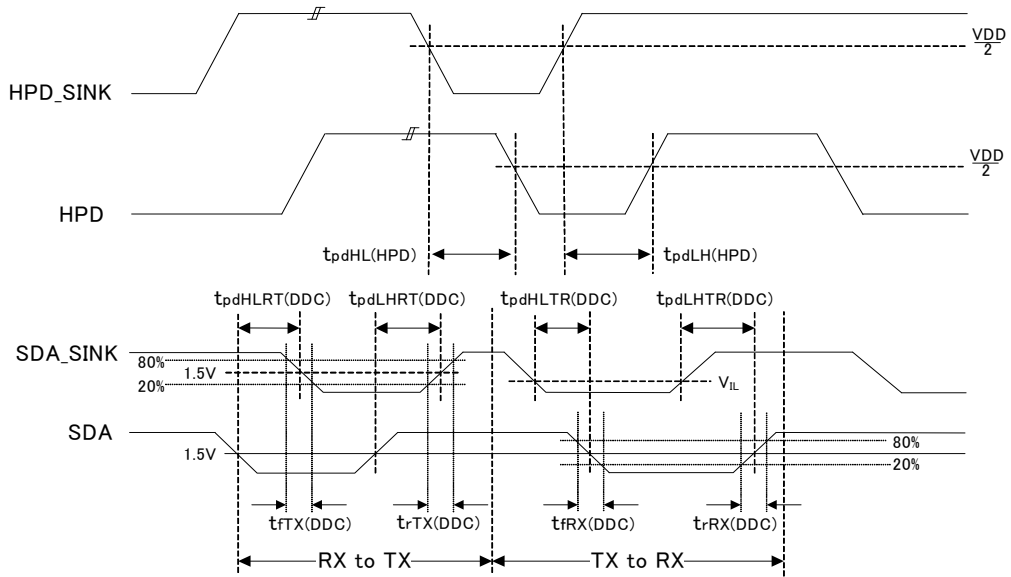
**Figure 5-1. Termination for TMSD Output Driver**



**Figure 5-2. Timing Test Circuit and Definitions**



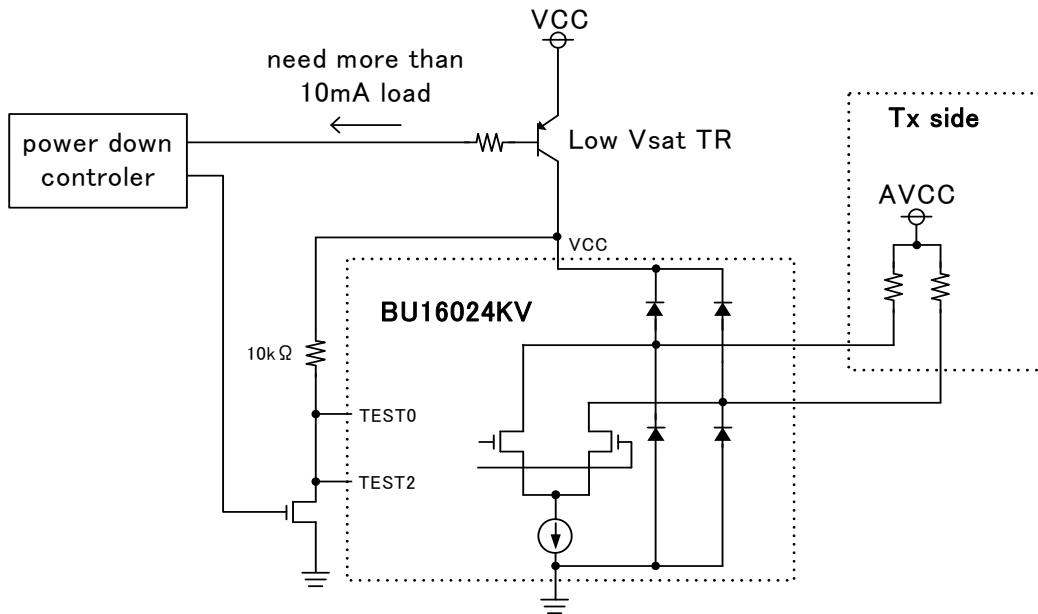
**Figure 5-3. Definition of Intra-Pair Differential Skew**



**Figure 5-4. DDC and HPD Timing Definitions**

1). Y and Z terminal ESD Diode notice.

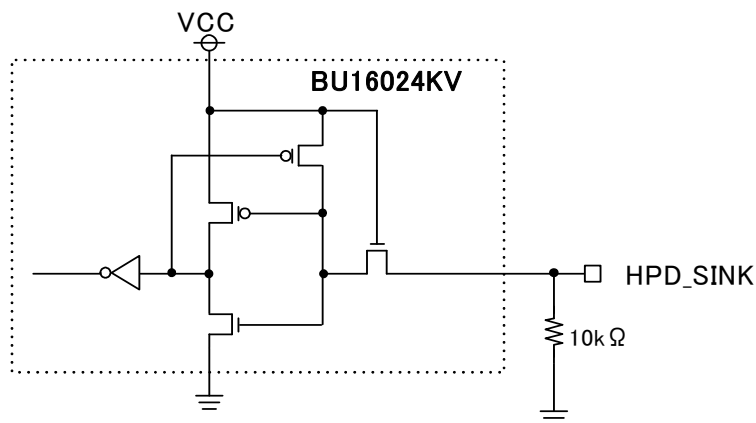
Y and Z terminals are connected ESD diode.  
 When  $VCC + 0.4 < AVCC$ .  
 BU16024KV flow leak current from AVCC to VCC.  
 In order to minimize leak current.  
 Please use following application.  
 If you use "Repeater" or "output Buffer"



**Fig6-1 Ist mode application**

2). HPD\_SINK Pull down resistance.

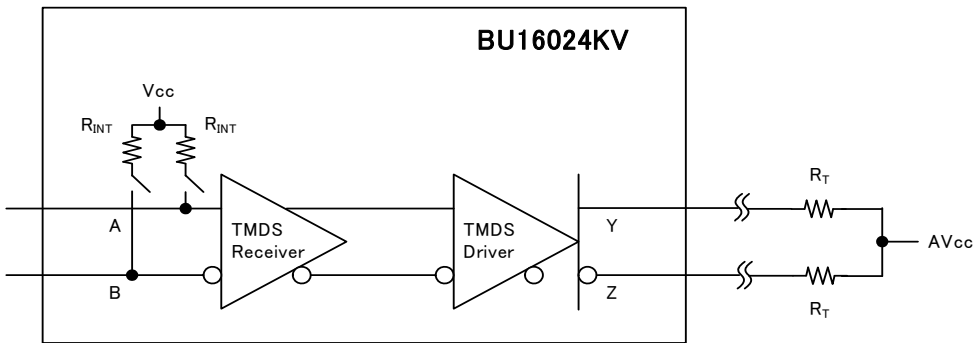
HPD\_SINK is a 5V tolerant structure shown in Fig6-2.  
 It needs some drive current to pull down HPD\_SINK "H" to "L"(max10uA@HPD\_SINK=2V).  
 So to pull down HPD\_SINK, please use 10kΩ (or under 10kΩ) resistor.



**Fig6-2 HPD\_SINK I/O schematic**

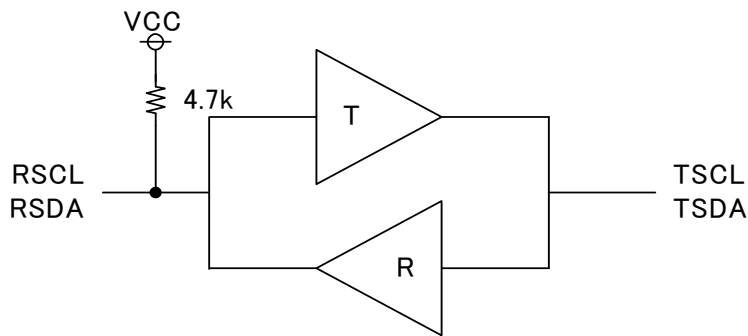
3). About don't use terminal.

Unused TMDS input channel can be opened.



**Fig6-3 TMDS Input Fail-Safe Recommendation**

Unused DDC Buffers of R side pulled up to Vdd .



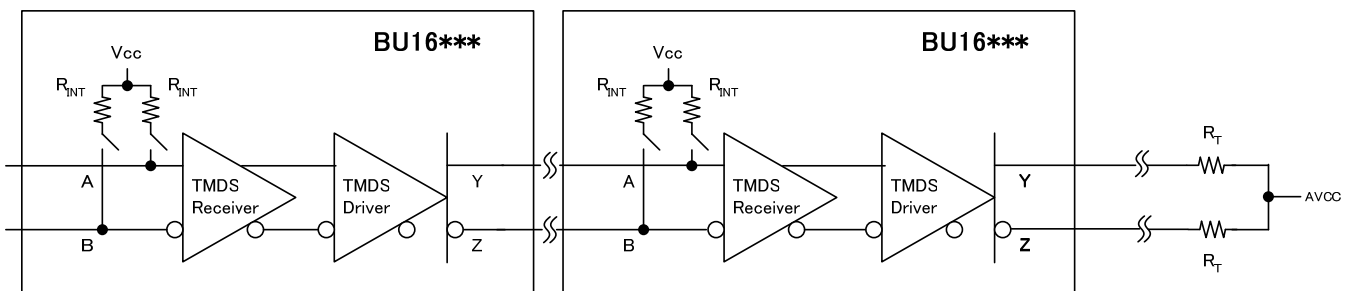
**Fig6-4 DDC Buffers in BU16024KV**

4). About serial connect notice.

When HDMI sw output connect to other HDMI sw input like following application.

There is possibility that. 1080p(12bit) image isn't displayed. It 's depend on receiver IC characteristic.

When system is required 1080p (12bit), Rohm doesn't recommend serial connect application.



**Fig6-5 serial connect notice**



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It is our top priority to supply products with the utmost quality and reliability. However, there is always a chance of failure due to unexpected factors. Therefore, please take into account the derating characteristics and allow for sufficient safety features, such as extra margin, anti-flammability, and fail-safe measures when designing in order to prevent possible accidents that may result in bodily harm or fire caused by component failure. ROHM cannot be held responsible for any damages arising from the use of the products under conditions out of the range of the specifications or due to non-compliance with the NOTES specified in this catalog.

Thank you for your accessing to ROHM product informations.

More detail product informations and catalogs are available, please contact your nearest sales office.

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