HDMI Switch ICs

1 for input 1 output buffer with Termination sense correspondence (Sync with HPD_SINK)

BU16024KV

No.09063EDT03

●Description

BU16024KV is 1 for input 1output 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

1) Supports 2.25 Gbps signaling rate for 480i/p, 720i/p, and 1080i/p resolution to 12-bit color depth
2) Compatible with HDMI 1.3a
3) 5V tolerance to all DDC and HPD_SINK inputs
4) Integrated DDC buffer
5) Integrated switchable 50Ωreceiver termination
6) Integrated equalizer circuit to adapt long cable
7) Selectable output De-Emphasis Supports
8) High Impedance outputs when disabled
9) HBM ESD protection exceed 10kV
10) 3.3-V supply operation
11) 48-Pin VQFP package
12) ROHS compatible

●Applications

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

●Line up matrix

Part No.	Power Supply (V)	ESD (KV)	Input (ch)	Output (ch)	Data rate (Gbps)	Hot Plug Control	Termination Sense Correspondence	Switching Method	DDC Buffer	Equalizer	De emphasis	Package	RoHS
BU16020KV	3 to 3.6	10	HDMI 4ch	HDMI 1ch	2.7	Yes	Yes	GPIO/I^{2}C	Yes	Yes (adaptive)	Yes	VQFP100	Yes
BU16018KV	3 to 3.6	10	HDMI 3ch	HDMI 1ch	2.25	Yes	Yes	GPIO	Yes	Yes	Yes	VQFP80	Yes
BU16027KV	3 to 3.6	10	HDMI 3ch	HDMI 1ch	2.25	Yes	Yes	GPIO	Yes	Yes	Yes (Always ON)	VQFP64	Yes
BU16006KV	3 to 3.6	10	HDMI 2ch	HDMI 1ch	2.25	Yes	Yes	GPIO	Yes	Yes	Yes (Always ON)	VQFP64	Yes
BU16024KV	3 to 3.6	10	HDMI 1ch	HDMI 1ch	2.25	Yes	Yes	-	Yes	Yes	Yes	VQFP48C	Yes

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●OUTSIDE DIMENSION CHART

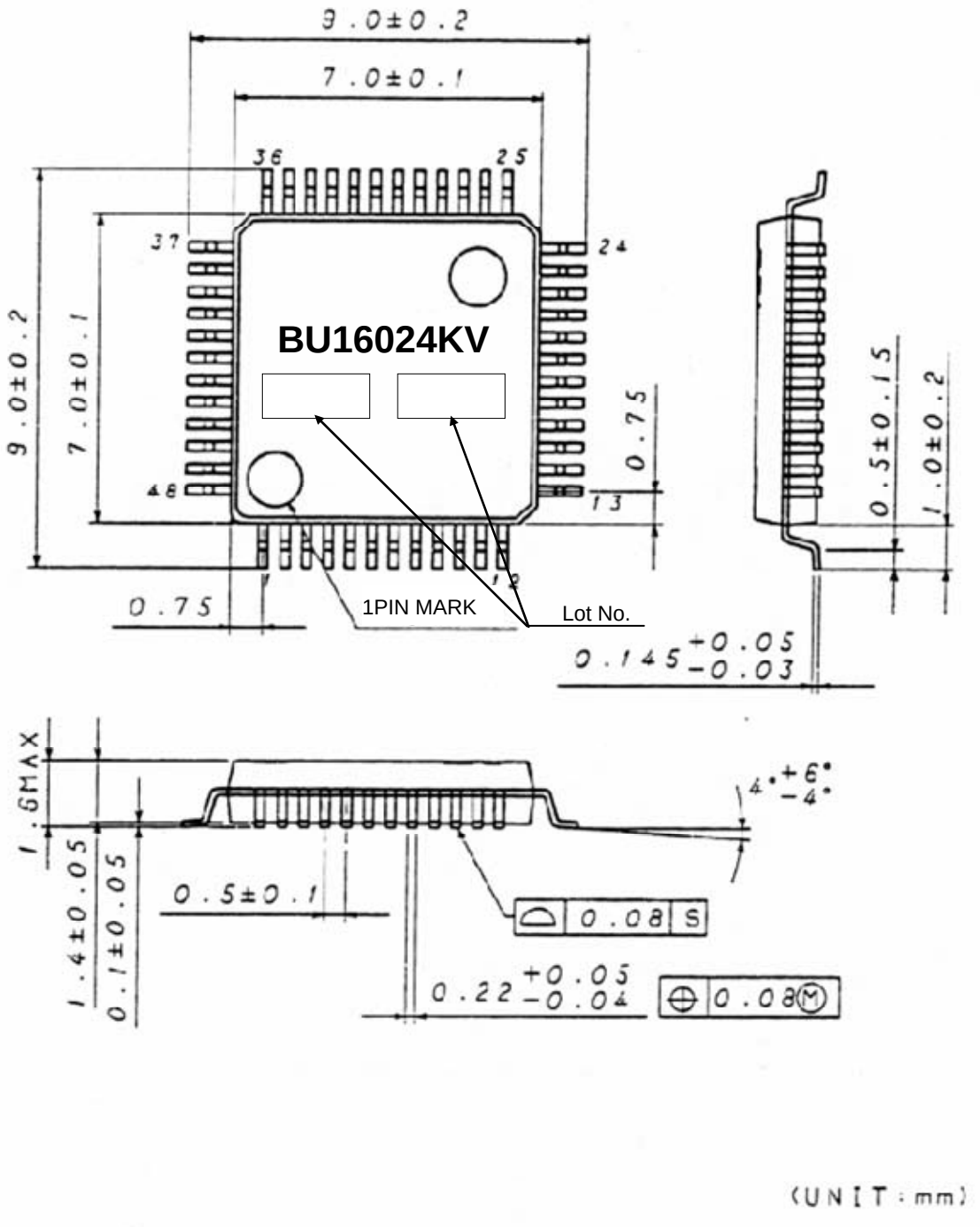

Figure 1-1 Outside dimension chart

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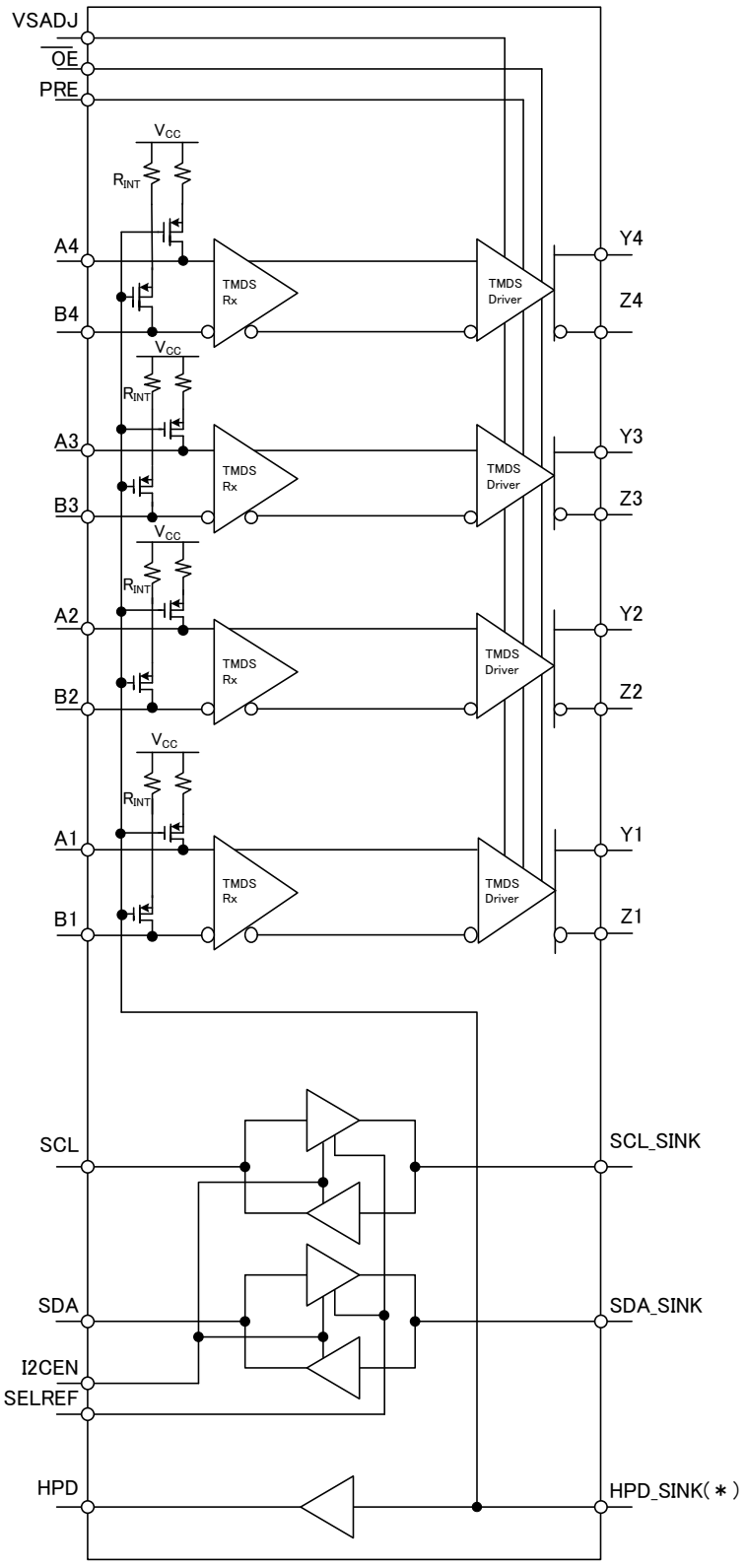
●BLOCK DIAGRAM



(＊) when HPD_SINK = "L". Termination resistor is turned off.

Figure 2-1 Block Diagram

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●PIN EXPLANATION

1). PIN ASSIGNMENT

(TOP VIEW)

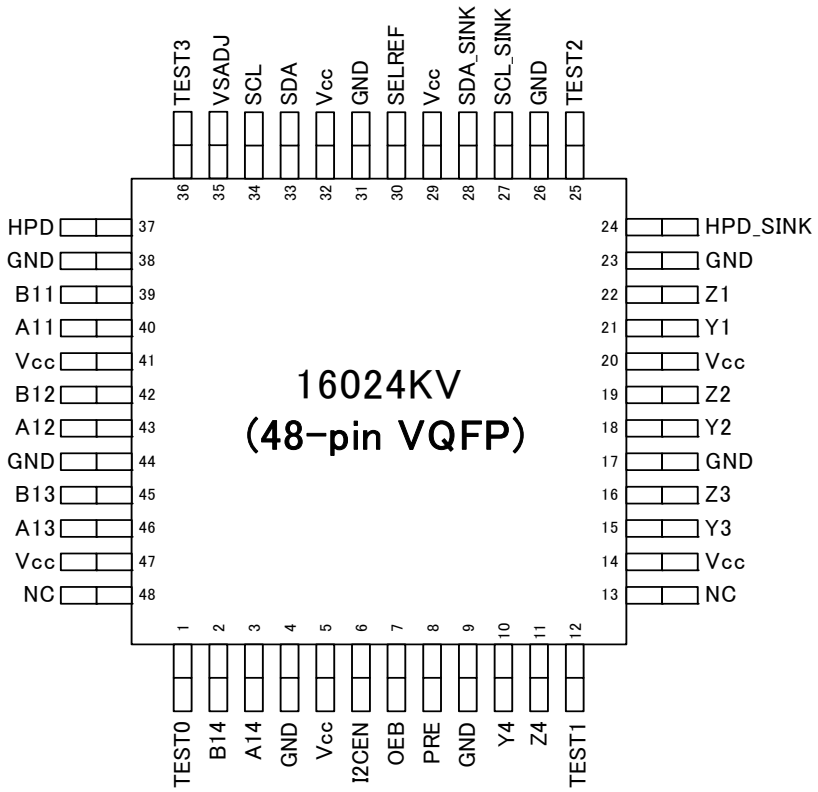

Figure 3-1 Pin Location

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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 4.64kΩ to GND)
I^2CEN	6	I	I^2C Repeater enable 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 Low : Active High : High-Z
PRE	8	I	TMDS Output de-emphasis adjustment Low : OFF High : ON
V_{CC}	5, 14, 20, 29, 32, 41, 47	-	Power supply
GND	4, 9, 17, 23, 26, 31, 38, 44	-	Ground

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● EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS

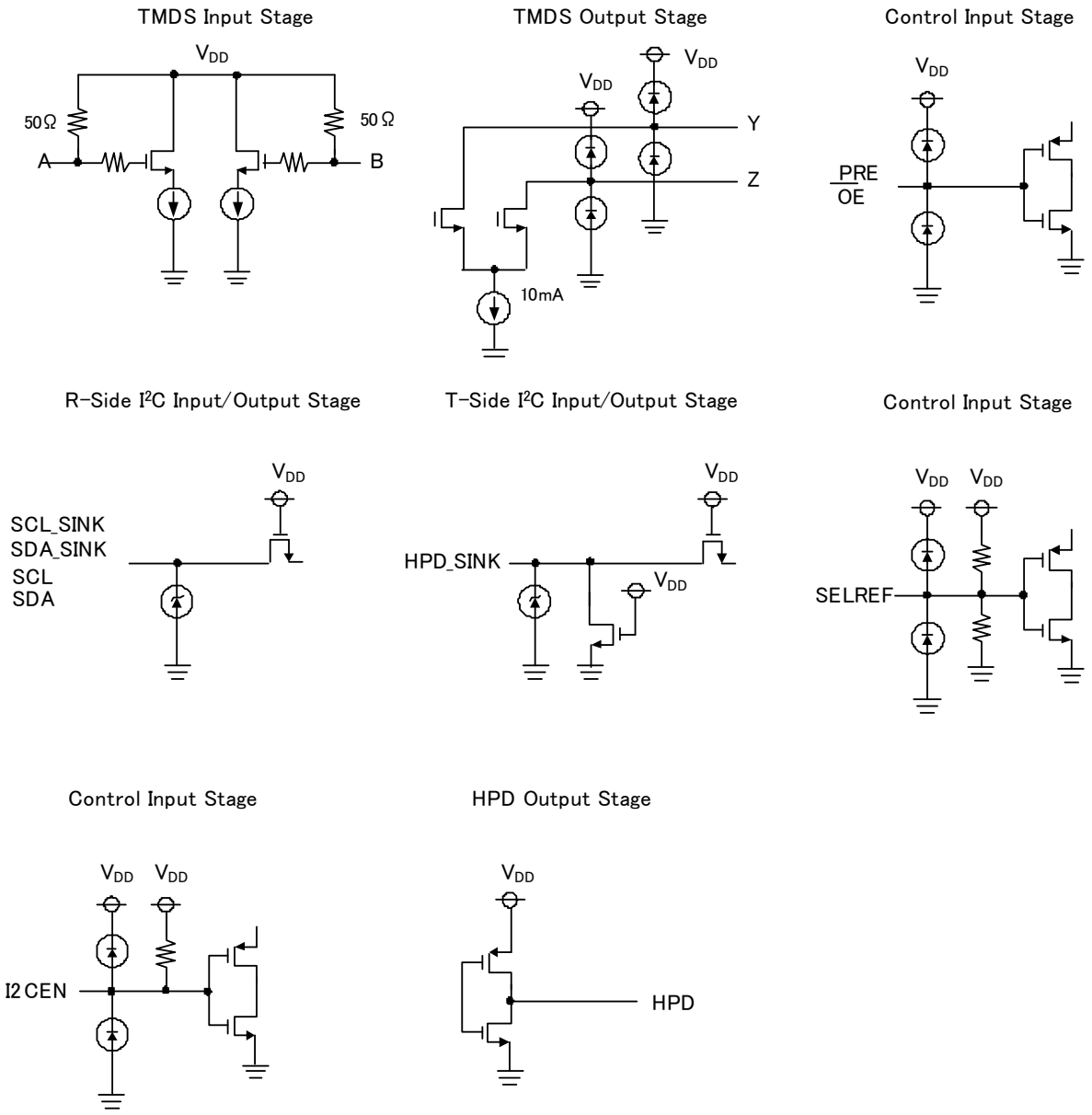

Figure 4-1 I/O pin schematic diagram

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●ERECTRICAL SPECIFICATIONS

1.）ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range (unless otherwise noted)(1)

ITEM	MIN.	TYP.	MAX.	UNIT
Supply voltage （Vcc）	-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^2CEN, SELREF, OEB input voltage	-0.3	-	4	V
Power dissipation	-	-	1200 ※1	mW
Storage temperature range	-55	-	125	℃

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

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

2.）RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	Supply voltage	3.0	3.3	3.6	V
T_A	Operating free-air temperature	0	-	70	℃
TMDS DIFFERENTIAL PINS (A/B)					
V_{ID}	Receiver peak-to-peak differential input voltage	150	-	1560	mVp-p
V_{IC}	Input common mode voltage	V_{CC}-0.6	-	V_{CC}+0.01	V
R_{VSADJ}	Resistor for TMDS compliant voltage swing range	4.6	4.64	4.68	kΩ
AV_{CC}	TMDS output termination voltage, see Figure 5-1	3	3.3	3.6	V
R_T	Termination resistance, see Figure 5-1	45	50	55	Ω
Signaling rate		0	-	2.25	Gbps
STATUS(HPD_SINK)					
V_{IH}	LVTTL High-level input voltage	2.4	-	5.5	V
V_{IL}	LVTTL Low-level input voltage	GND	-	0.8	V
DDC PINS (SCL_SINK, SDA_SINK,SDA,SCL)					
$V_{I(DDC)}$	Input voltage	GND	-	5.5	V

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3.) ELECTRICAL CHARACTERISTICS
Over recommended operating conditions (unless otherwise noted)

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

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SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS			UNIT
				MIN.	TYP.(1)	MAX	
DDC Input and output							
Tx (SDA_SINK , SCL_SINK)							
$I_{lkR①}$	Input leak current,	V_I = 5.5V		-10	-	10	uA
$I_{lkT②}$	Input leak current,	V_I = Vcc		-10	-	10	uA
I_{OHT}	High-level output current	V_O = 3.6V		-10	-	10	uA
I_{ILT}	Low-level input current	V_{IL} = GND		-10	-	10	uA
V_{OLT}	Low-level output voltage	RL = 4.7kΩ	SELREF = NC	0.43	-	0.57	V
			SELREF= GND	0.58	-	0.72	
			SELREF = Vcc	0.73	-	0.87	
V_{OLT} - V_{IL}	Low-level input voltage below output low-level voltage		SELREF = NC	-	100	-	mV
			SELREF= GND	-	250	-	
			SELREF = Vcc	-	400	-	
Rx (SDA, SCL)							
$I_{I kR①}$	Input leak current	V_I = 5.5V		-10	-	10	uA
$I_{I kR②}$	Input leak current	V_I = Vcc		-10	-	10	uA
I_{OHR}	High-level output current	V_O = 3.6V		-10	-	10	uA
I_{ILR}	Low-level input current	V_{IL} = GND		-10	-	10	uA
V_{OLR}	Low-level output voltage	I_{OUT} = 4mA		-	-	0.2	V
STATUS PINS (HPD)							
$V_{OH (TTL)}$	TTL High–level output voltage	I_{OH} = - 8mA		2.4	-	Vcc	V
$V_{OL (TTL)}$	TTL Low–level output voltage	I_{OL} = 8mA		0	-	0.4	V
CONTROL PINS (PRE, OEB)							
I_{IH}	High–level digital input current	V_{IH} = Vcc		-10	-	10	uA
I_{IL}	Low–level digital input current	V_{IL} = GND		-10	-	10	uA
CONTROL PINS (I^2CEN, SELREF,)							
I_{IH}	High–level digital input current	V_{IH} = Vcc		-45	-	45	uA
I_{IL}	Low–level digital input current	V_{IL} = GND		-45	-	45	uA
STATUS PINS (HPD_SINK)							
$I_{I H}$	High–level digital input current	V_{IH} = 5.5V		10	50	100	uA
		V_{IH} = Vcc		5	30	80	uA
$I_{I L}$	Low–level digital input current	V_{IL} = GND		-10	-	10	uA

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SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			MIN.	TYP.(1)	MAX.	
TMDS DIFFERENTIAL PINS (Y/Z)						
t_{PLH}	Propagation delay time low-high-level output	See Figure5-2, AV_{CC} = 3.3V, R_T = 50Ω, PRE ="H"	-	320	-	ps
t_{PHL}	Propagation delay time high-low-level output		-	335	-	ps
t_r	Differential output signal rise time (20%-80%)		-	120	-	ps
t_f	Differential output signal fall time (20%-80%)		-	120	-	ps
$t_{sk(p)}$	Pulse skew ($\|t_{PHL} - t_{PLH}\|$)		-	15	-	ps
$t_{sk(D)}$	Intra-pair differential skew, see Figure5-3		-	25	-	ps
DDC I/O PINS (SCL, SCL_SINK, SDA, SDA_SINK)						
t_{pdLHTR} (DDC)	Propagation delay time, low-to-high-level output Tx to Rx	R_L = 4.7KΩ C_L = 100pF	-	650	-	ns
t_{pdHLTR} (DDC)	Propagation delay time, high-to-low-level output Tx to Rx		-	200	-	ns
t_{pdLHRT} (DDC)	Propagation delay time, low-to-high-level output Rx to Tx	R_L = 1.67KΩ C_L = 400pF	-	500	-	ns
t_{pdHLRT} (DDC)	Propagation delay time, high-to-low-level output Rx to Tx		-	350	-	ns
tr $Tx_{(DDC)}$	Tx output Rise time	R_L = 4.7KΩ C_L = 100pF	-	800	-	ns
tf $Tx_{(DDC)}$	Tx output Fall time		-	150	-	ns
tr $Rx_{(DDC)}$	Rx output Rise time	C_L=10pF	-	950	-	ns
tf $Rx_{(DDC)}$	Rx output Fall time		-	50	-	ns
C_{IO}	Input/output capacitance	V_I=0V		15		pF
STATUS PINS(HPD)						
$t_{pdLH(HPD)}$	Propagation delay time, low-to-high-level output from HPD_SINK to HPD	C_L=10pF	-	5	-	ns
$t_{pdHL(HPD)}$	Propagation delay time, high-to-low-level output from HPD_SINK to HPD	C_L=10pF	-	5	-	ns
$t_{sx(HPD)}$	Switch time from port select to the latest valid status of HPD	C_L=10pF	-	8	-	ns

Note:
All typical values are at 25℃ and with a 3.3V supply.

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●MEASUREMENT SYMBOL AND CIRCUIT

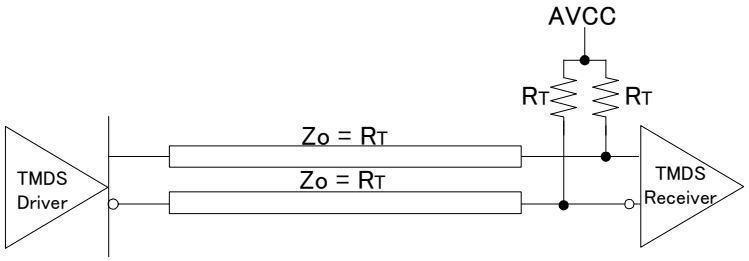
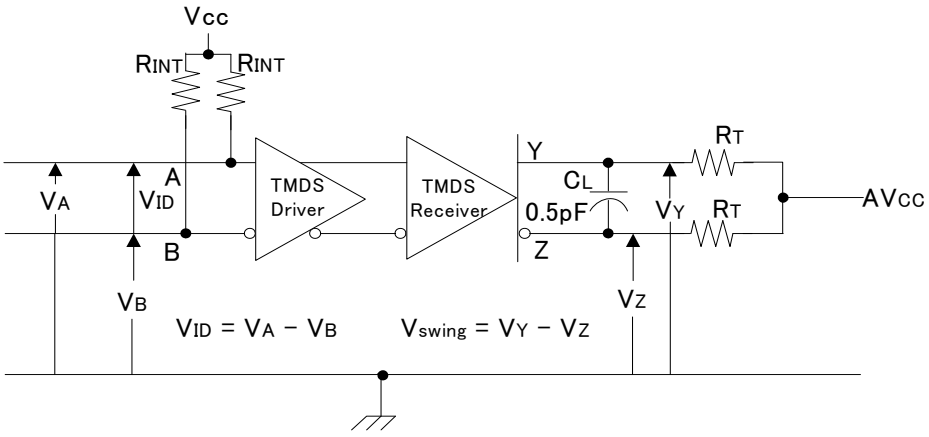


Figure 5-1 Termination for TMDS Output Driver



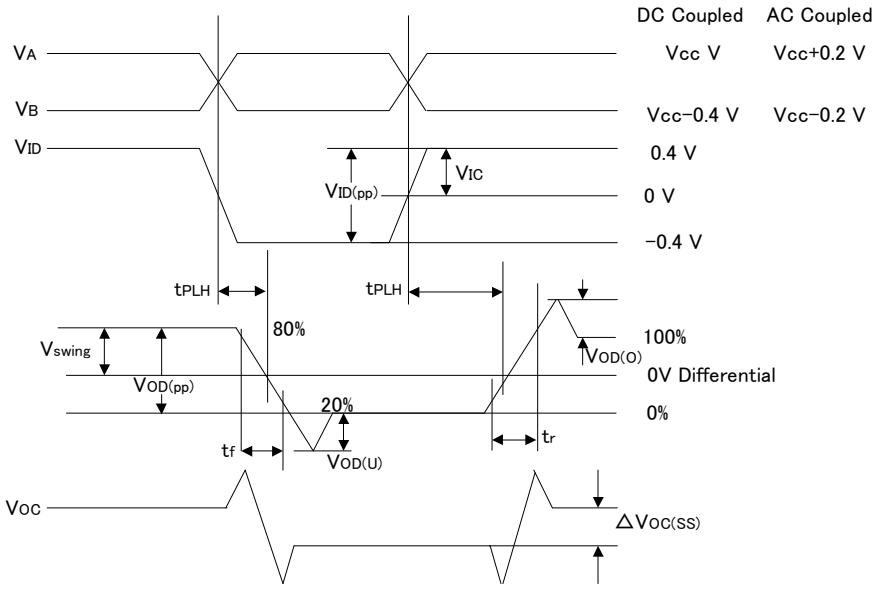


Figure 5-2 Timing Test Circuit and Definitions

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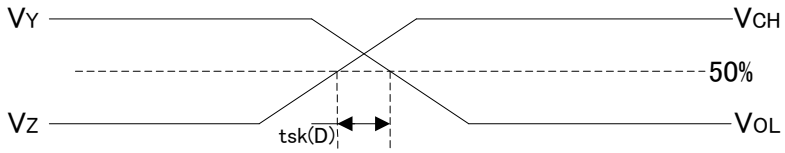

Figure 5-3 Definition of Intra-Pair Differential Skew

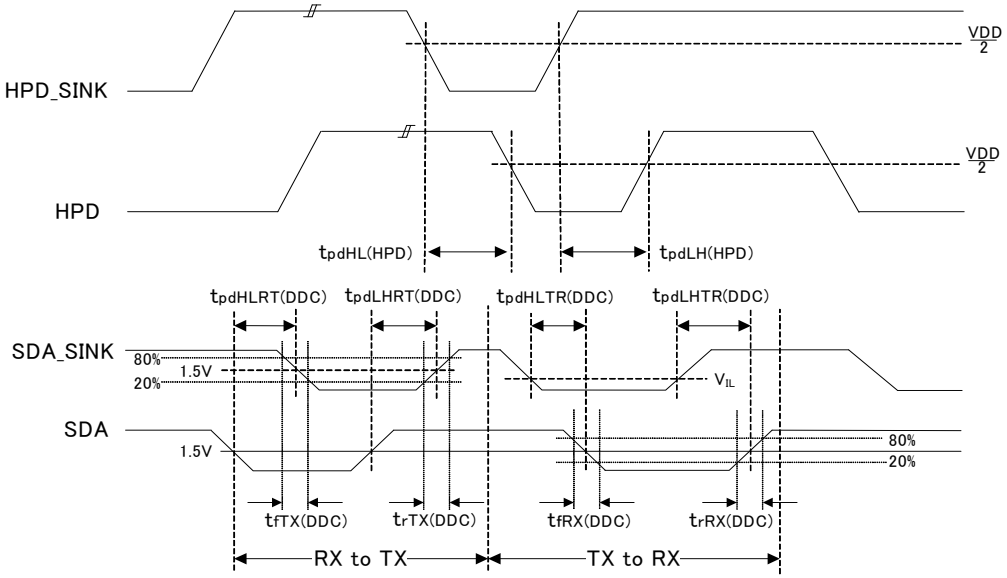

Figure 5-4 DDC and HPD Timing Definitions

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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 pass the compliance test.
You must use mandatory application, refer Figure 6-1 for “Repeater” or “output Buffer” application.
If you use “Repeater” or “output Buffer”

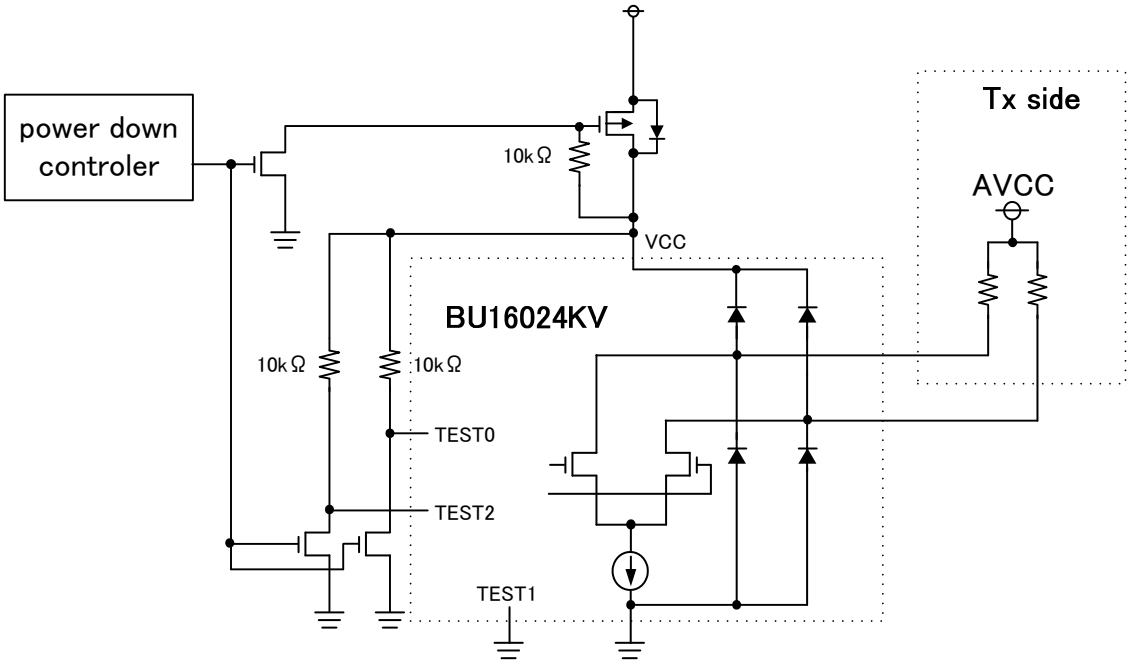

Figure 6-1 Leak current control

2). HPD_SINK Pull down resistance.

HPD_SINK is a 5V tolerant structure shown in Figure 6-2.
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.

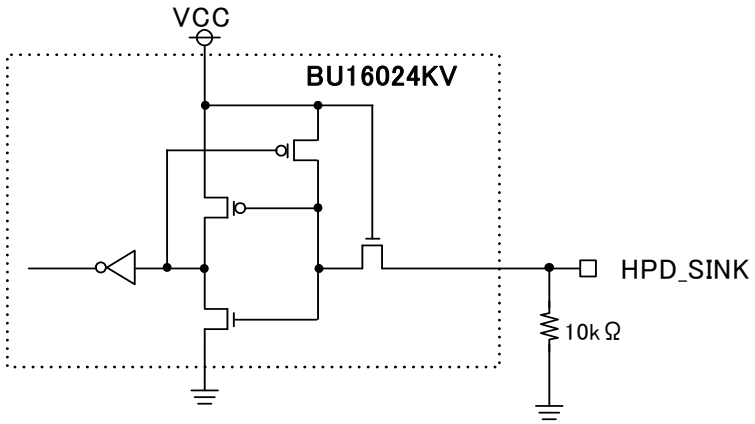

Figure 6-2 HPD_SINK I/O schematic

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3). About don't use terminal.
Unused TMDS input channel can be opened.

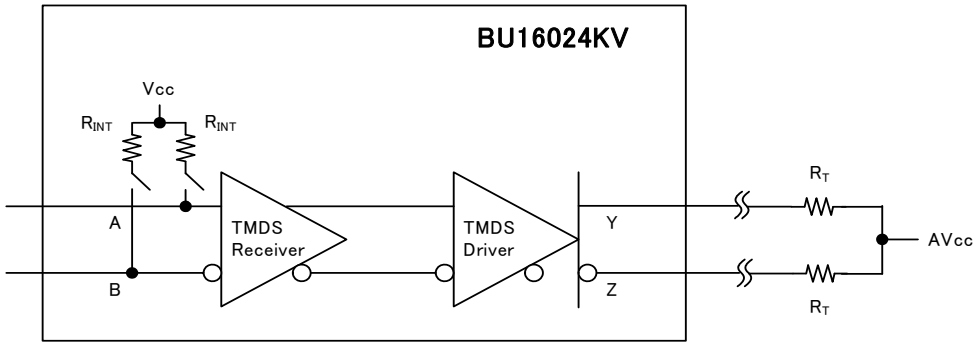

Figure 6-3 TMDS Input Fail-Safe Recommendation

Unused DDC Buffers of R side polled up to Vdd .

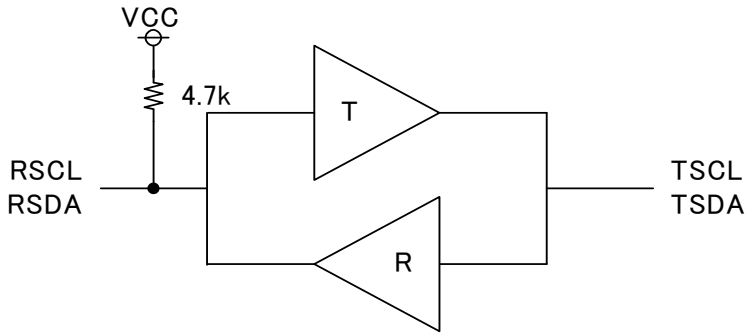

Figure 6-4 DDC Buffers in BU16024KV

Open unused HPDn.

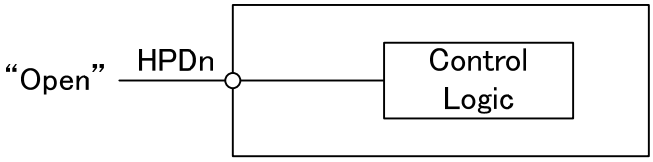

Figure 6-5 Open unused HPDn

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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.

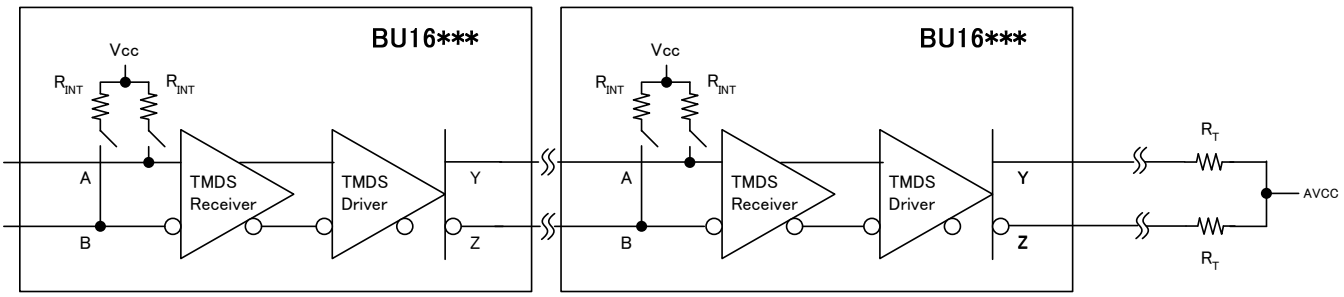

Figure 6-6 serial connect notice

5). AC Coupling capable.

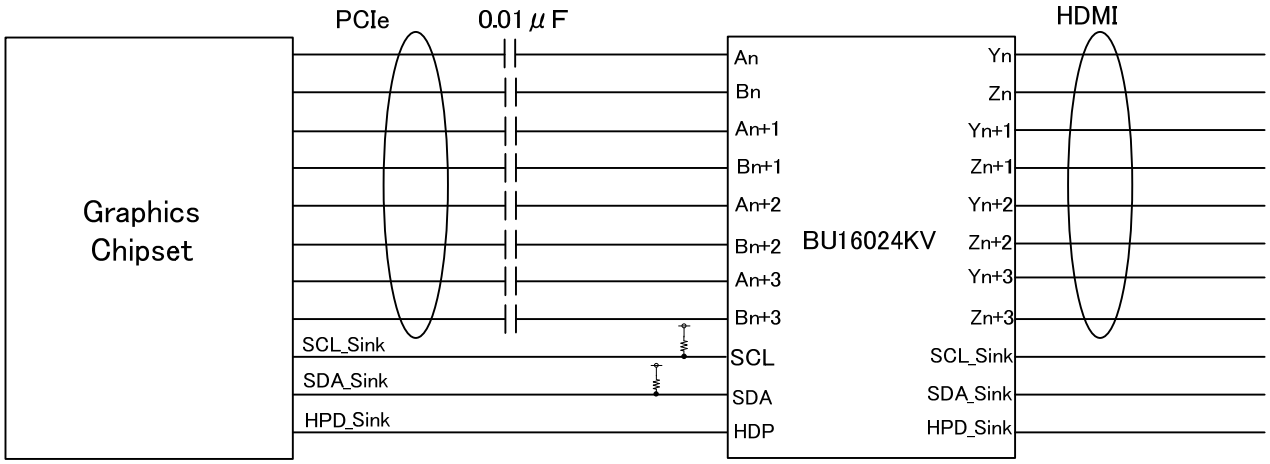

Figure 6-7 AC Coupling capable

6). Offset voltage appearance.
If differential input is opened, offset voltage appear at differential output OE is set to low to avoid it.

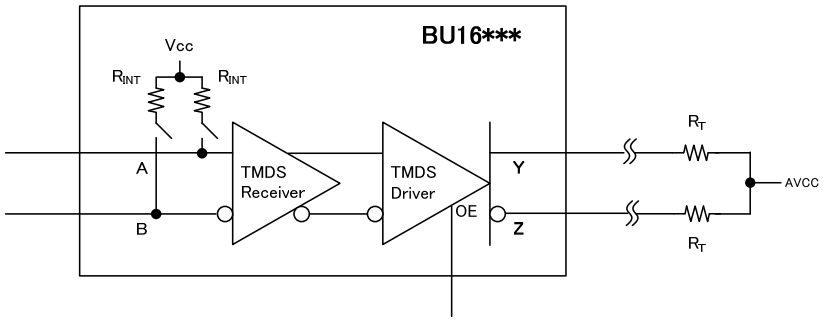

Figure 6-8 Offset voltage avoid

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7）. Limitation of Master and slave direction.

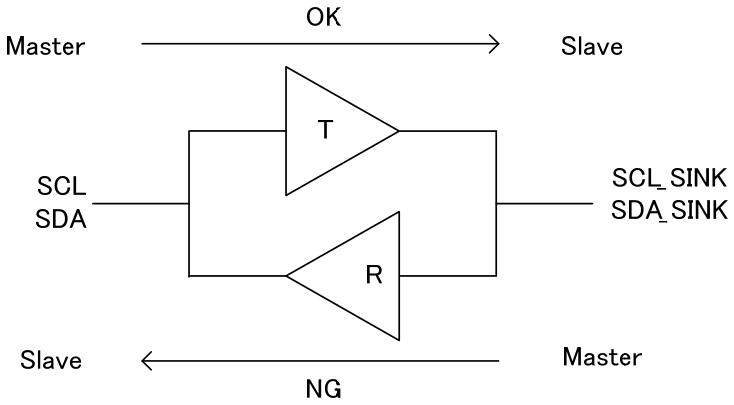

Figure 6-9 Limitation of Master and slave direction

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●Ordering part number

B	U	1	6	0	2	4		K	V	—	E	2

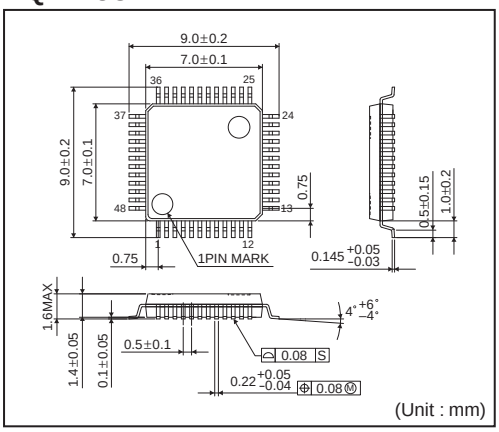
ROHM model name

Package type
VQFP48C

Packaging and forming specification
E2 =Reel-shaped emboss taping

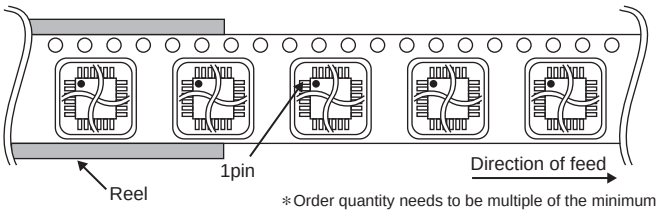
●Package specification

VQFP48C



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

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