

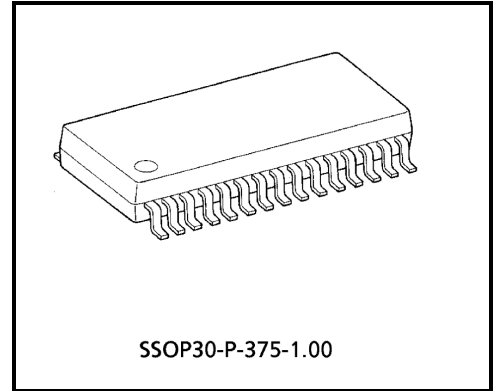
TB2104F

VFD Driver

The TB2104F is a VFD (fluorescent display tube) driver IC implemented by the Bi-CMOS process. The logic section is configured with CMOS transistors, and the high voltage tolerant output driver section is configured with bipolar transistors.

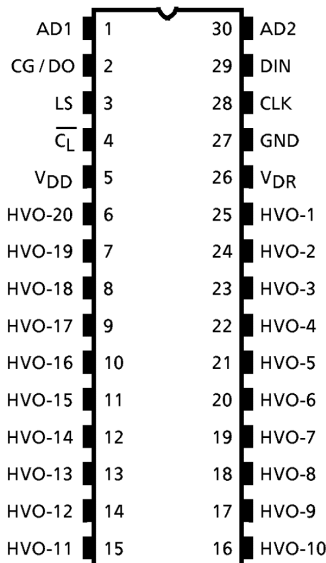
Features

- Incorporates a shift register, latch, and driver capable of handling 20 bits of data.
- The output driver comes with an active pull-down, so it can function as a VFD grid, anode driver.
- Three serial data lines are used to input display data.
- The data receiver section can also accept general-purpose serial data and T-BUS (TOSHIBA semiconductor bus).
- In serial data mode, multiple drivers can be cascaded to expand the handling capacity in 20bit increments.

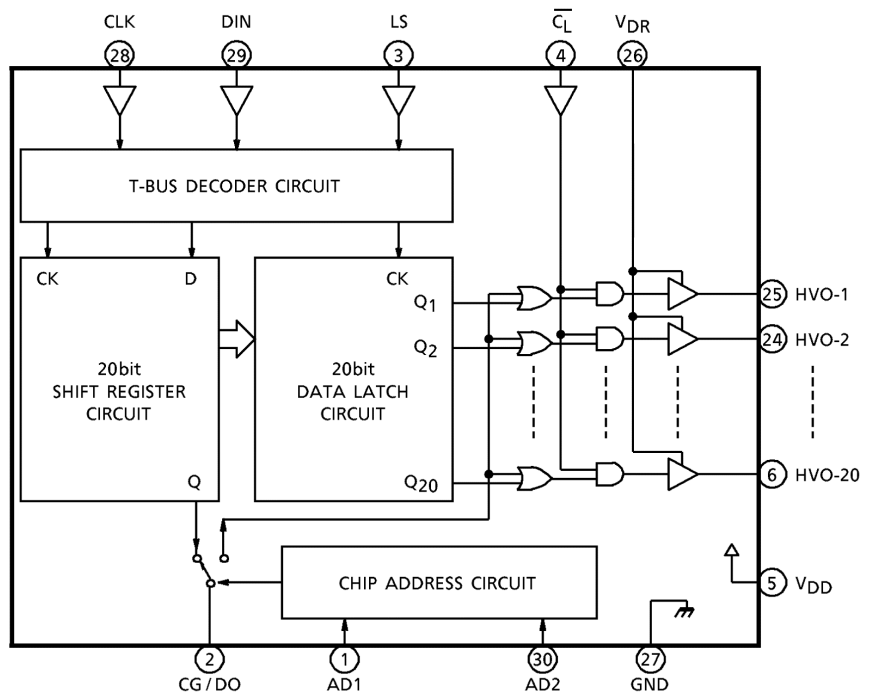


Weight: 0.7g (typ.)

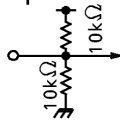
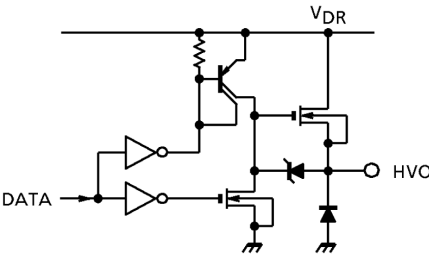
Pin Connection



Block Diagram



Pin Function

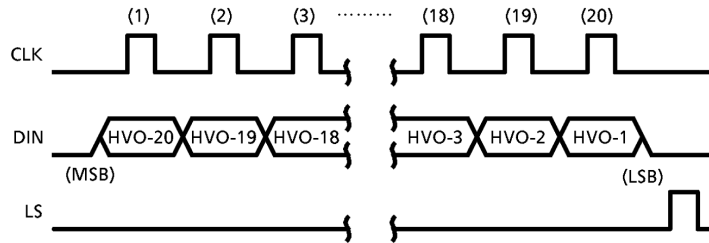
Pin No.	Symbol	Pin Name	Function And Operation	Remarks
1	AD1	Address setting input	<ul style="list-style-type: none"> • Chip select / address setting inputs • When using in serial mode, keep AD1 and AD2 "open". • In other settings than "open", it becomes T-BUS mode and addresses up to 8 kinds can be set. 	3-value input 
30	AD2			
3	LS	Strobe input	<ul style="list-style-type: none"> • Serial data input terminals • Inputs display data through the DIN terminal synchronizing with rise of CLK input. • Display data are updated when inputting "H" level into LS terminal after completing data input. • In T-BUS mode, LS terminal becomes "period" input. 	CMOS input
28	CLK	Clock input		
29	DIN	Data input		
2	CG / DO	Lamp test input and data output	<ul style="list-style-type: none"> • Lamp test input terminal and data output terminal • In serial mode (AD1 = AD2 = open), this terminal serves as the serial data output terminal and enables cascade connection of driver IC. • In T-BUS mode, this terminal serves as the lamp test input and is able to use all the driver outputs (HVO-1~20) at "H" level by inputting "H" level signal. • During the normal operation in T-BUS mode, use this terminal by fixing at "L" level. 	CMOS input / CMOS output built in pull-down resistor 20kΩ
4	\overline{CL}	Clear input	<ul style="list-style-type: none"> • Driver off (blinking) input terminal • All the driver outputs are fixed at "L" level when "L" level signal is input. • When "H" level signal is input, it becomes the normal mode. 	CMOS input built in pull-up resistor 20kΩ
5	V _{DD}	Logic unit power supply	<ul style="list-style-type: none"> • Power supply and GND terminals 	—
26	V _{DR}	Drive unit power supply		
27	GND	Ground		
25 24 23 ⋮ ⋮ 8 7 6	HVO-1 HVO-2 HVO-3 ⋮ ⋮ HVO-18 HVO-19 HVO-20	Driver output	<ul style="list-style-type: none"> • High-tension driver output terminal • Equivalent circuit 	—

Explanation Of Operation

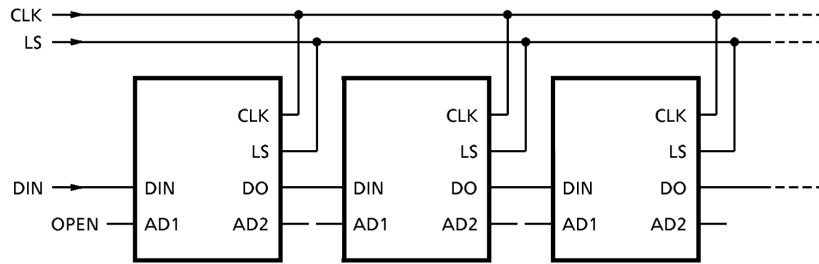
1. Serial data receiver circuit

- The serial data receiver circuit can be changed over to operate in the serial mode or the T-BUS mode by switching, the AD1 / AD2 terminals.
- In T-BUS mode, the AD1 / AD2 terminals become the chip select code inputs and it becomes possible to connect up to 8 drivers on the same bus line.

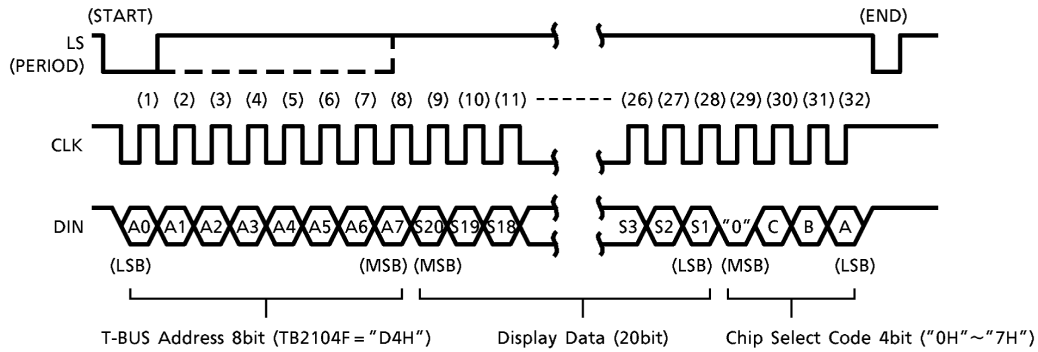
1) Input data format in serial data mode (AD1 = AD2 = "open")



- Display data are updated when data for 20 bits are input from MSB side (HVO-20), synchronizing with rise of CLK signal and LS input is set to "H" level after inputting data.
- When increasing driver ICs, connect them through cascade connection as shown below:



2. Input data format in T-BUS mode



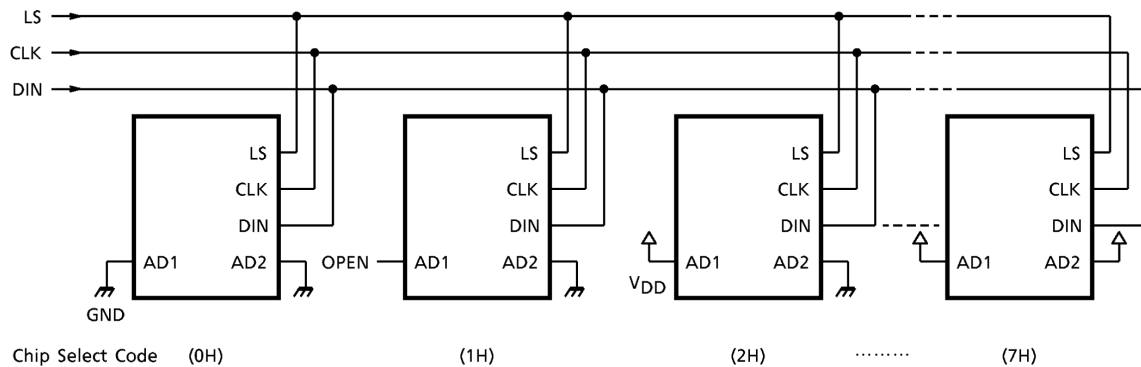
- In T-BUS mode, start data transmission with the LS terminal (period) set at “L” level. Thereafter, send address data 8 bits, display data 20 bits, and chip select code 4 bits, synchronizing with rise of CLK signal.
- After sending data, set the LS terminal to “L” level again and terminate the data sending.
- On a driver IC when chip select code agrees with chip select code by AD1 / AD2, display data are updated at fall of LS signal.
- When increasing driver ICs, it is possible to connect up to 8 ICs on the same bus line in combination with AD1 / AD2.
- T-BUS address of the TB2104F is “D4H”.
- When data are transferred using T-BUS address “00H”, the data can be input to all the driver ICs on the bus line independently of chip select codes (“0H”~“7H”). (This function can be used for power on reset.)

3. AD1 / AD2 input and chip select codes

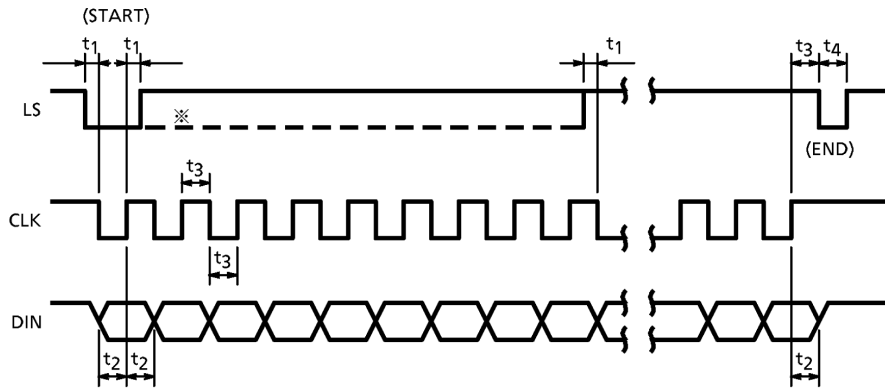
AD1 / AD2 input are 3-value level inputs and 9 kinds (3×3) of codes can be set.

AD1	AD2	A	B	C	Chip Select Code	Mode
V _{IH}	V _{IH}	1	1	1	“7H”	T-BUS
V _{IM}		0	1	1	“6H”	
V _{IL}		1	0	1	“5H”	
V _{IH}	V _{IM}	0	0	1	“4H”	Serial
V _{IM}		—	—	—	—	
V _{IL}		1	1	0	“3H”	
V _{IH}	V _{IL}	0	1	0	“2H”	T-BUS
V _{IM}		1	0	0	“1H”	
V _{IL}		0	0	0	“0H”	

4. Example of extension of driver ICs in T-BUS mode chip select code



5. T-BUS mode timing chart



- $f_{CLK} \leq 500\text{kHz}$
- $t_1 \geq 0.2\mu\text{s}$, $t_2 \geq 0.2\mu\text{s}$
- $t_3 \geq 1.0\mu\text{s}$, $t_4 \geq 1.0\mu\text{s}$

Cautions for use

- Therefore, multiple driver outputs may possibly become “H” level simultaneously after the power is turned on.
(In this case, the allowable power dissipation of a device using this IC may possible be exceeded, destroying the device.)
- In order to avoid this, while keeping the clear terminal ($\overline{C_L}$) at “L” level, rise the power supply for the logic unit (V_{DD}) and then, that for the drivers (V_{DR}), reset all the contents of the data latch (“L” level) by serial data, and initialize the driver outputs.

Maximum Ratings (Ta = 25°C)

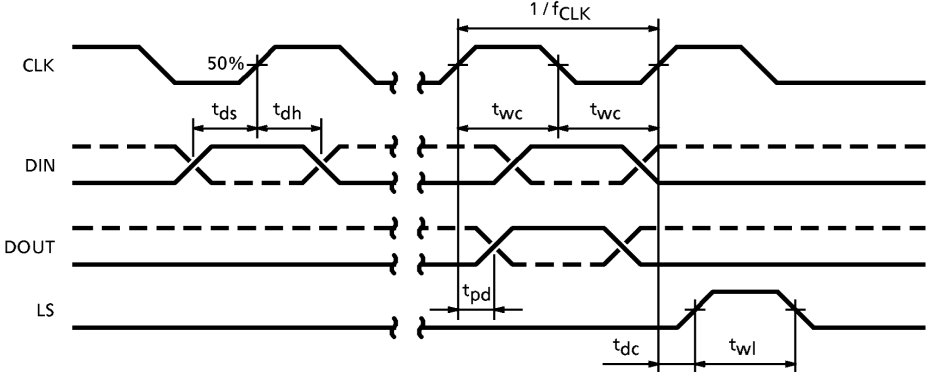
Characteristic	Symbol	Rating	Unit
Supply voltage	V _{DD}	-0.3~7.0	V
Input voltage	V _{IN}	-0.3~V _{DD} +0.3	V
Driver voltage	V _{DR}	V _{DD} ~60	V
Driver current	I _{DR}	50	mA
Power dissipation	P _D (Note)	800	mW
Operating temperature	T _{opr}	-40~85	°C
Storage temperature	T _{stg}	-55~150	°C

(Note) In case it is used at more than Ta = 25°C, it is considered by reducing 6.4mW each 1°C.

Electrical Characteristics (unless otherwise specified, V_{DD} = 5V, V_{DR} = 50V, Ta = 25°C)

Characteristic		Symbol	Test Circuit	Test Condition	Min.	Typ.	Max.	Unit	
Operating supply voltage (1)		V _{DD}	—	Logic unit	4.5	5.0	5.5	V	
Operating supply voltage (2)		V _{DR}	—	Driver unit	10	~	50	V	
Operating supply current (1)		I _{DD}	—	No load, no input	—	0.3	1.5	mA	
Operating supply current (2)		I _{DR}	—	No load, output V _{OL} level	—	2.3	3.5	mA	
Input voltage	"H" level	V _{IH} (1)	—	CMOS input terminal DIN, CLK, LS, CG, C _L	V _{DD} ×0.7	~	V _{DD}	V	
	"L" level	V _{IL} (1)			GND	~	V _{DD} ×0.3		
Input voltage	"H" level	V _{IH} (2)	—	3-value input terminal AD1, AD2	V _{DD} -0.5	~	V _{DD}	V	
	Open	V _{IM}			—	V _{DD} ×0.5	—		
	"L" level	V _{IL} (2)			GND	~	GND +0.5		
Input current	"H" level	I _{IH}	—	CMOS input terminal	V _{IH} = 5V	~	1.0	μA	
	"L" level	I _{IL}			V _{IL} = 0V	~	1.0		
Input resistance		R _{IN}	—	3-value input terminal	80	100	120	kΩ	
Output current	"H" level	I _{OH} (1)	—	HVO-1~-20 output terminal	V _{OH} = 45V	—	-8.4	-5	mA
	"L" level	I _{OL} (1)			V _{OL} = 3V	2.0	2.7	—	
Output current	"H" level	I _{OH} (2)	—	DO output terminal	V _{OH} = 4V	—	-0.3	-0.1	mA
	"L" level	I _{OL} (2)			V _{OL} = 1V	0.1	0.3	—	
Clock frequency		f _{CLK}	Fig. 1	CLK max. operating	—	5.0	4.0	MHz	
Clock pulse width		t _{wc}		CLK min. operating	75	60	—	ns	
Data setup time		t _{ds}		DIN min. operating pulse width	50	40	—	ns	
Data hold time		t _{dh}			50	40	—	ns	
LS pulse width		t _{wl}		LS min. operating	80	60	—	ns	
CLK-LS delay time		t _{dc}		CLK→LS delay time	50	40	—	ns	
CLK-DOUT delay time		t _{pd}		CLK→DOUT delay time CL = 30pF	—	120	160	ns	

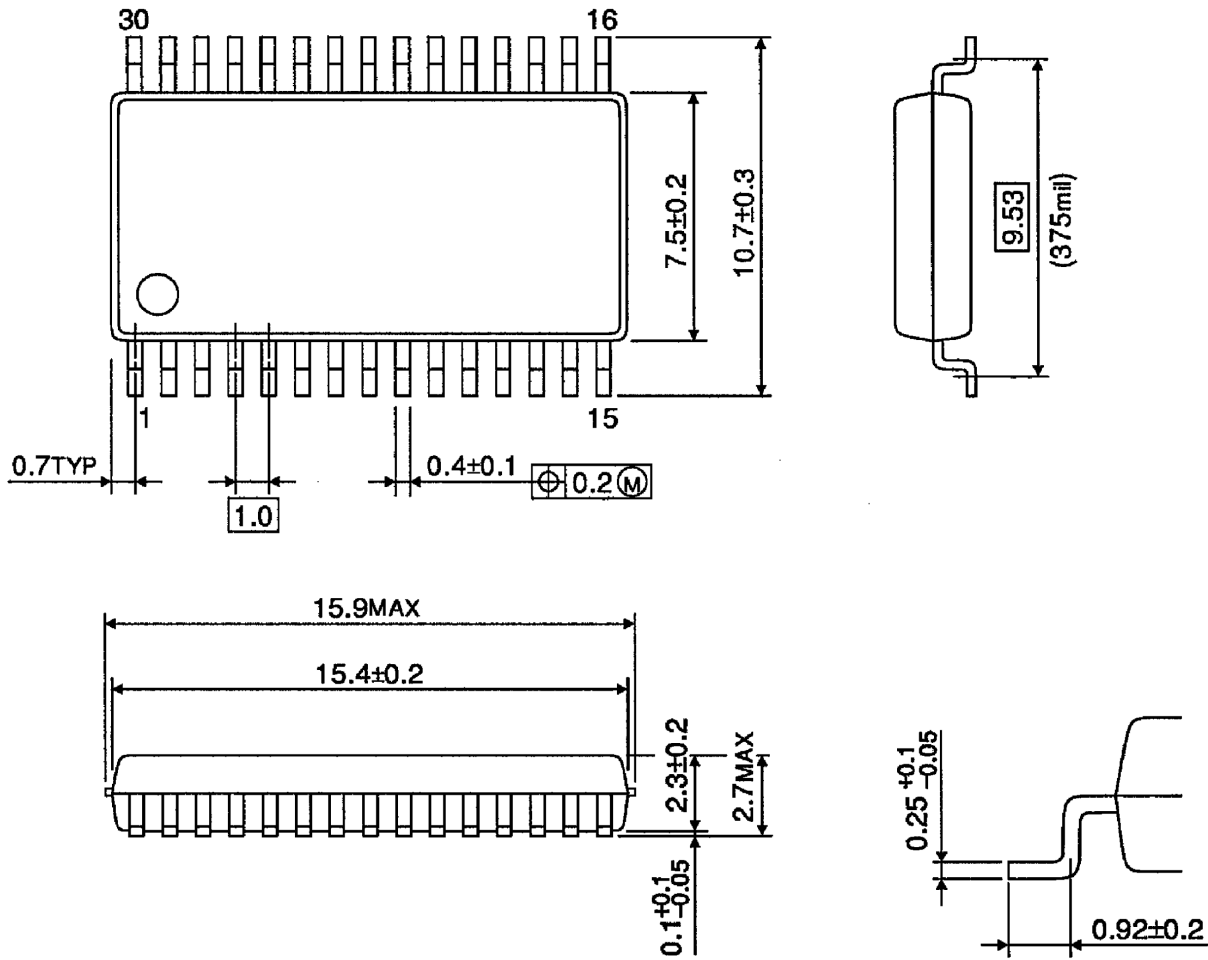
Fig. 1: Serial data timing chart



Package Dimensions

SSOP30-P-375-1.00

Unit : mm



Weight: 0.7g (typ.)

RESTRICTIONS ON PRODUCT USE

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