TCIB04 / 06: 4-/6-Channel Automotive Non-Inverting 3-State Buffer

1. Features

- AEC-Q100 Grade 1 Qualified and PPAP Capable
- Wide power supply range: 1.65V~5.5V
- Sink/Source current up to 16mA at 5V
- Rising/Falling Time: Typical 1.1ns/0.7ns with 10pF Cload
- Rising/Falling Delay Time: Typ. 2.9ns/2.1ns w/ 10pF Cload
- Schmitt-trigger inputs allow for slow or noisy input signals
- Low power consumption
  - Typical supply current I_{VCC} 0.5uA
  - Typical input leakage current I_{IL} < 0.1uA
- Operating temperature T_A: -40~125°C
- Packages：
  - TSSOP-14
  - QFN-20
  - TSSOP-20
- ESD：±2KV（HBM）/ ±2KV（CDM）

2. Applications

- Signal buffers in Automotive applications
- Eliminate slow or noisy input signals
- Control an indicator LED
- Debounce a switch
- Enable or disable a digital signal

3. Description

TCIB04/06 is a multiple-channel non-inverting 3-state buffer in different packages. QFN20/TSSOP20 packages are for 6-channel buffer and TSSOP14 for 4-channel buffer.

All the channels can work independently, which means each channel has the dedicated control pin to turn on or off the buffer separately. Both OEn and An input signals are with Schmitt trigger. Output Yn is high impedance when OEn is low.

Product Information:

Part Number	Package	Body Size (Nom.)
TCIB04A-T5A1	TSSOP14	5mm X 4.4mm
TCIB06A-QBA1	QFN20	2.5mm X 3.5mm
TCIB06A-TBA1	TSSOP20	6.5mm X 4.4mm

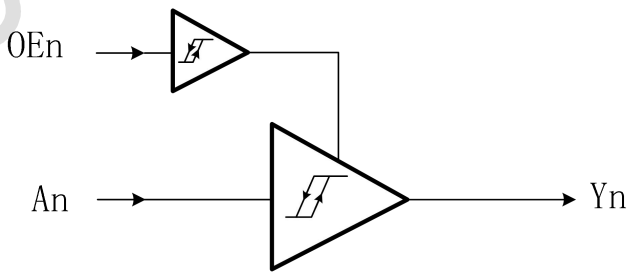

Fig. 1 Block Diagram

n : 4 for TCIB04, or 6 for TCIB06

TOC

4. PINOUT

4.1. 20-Pin QFN

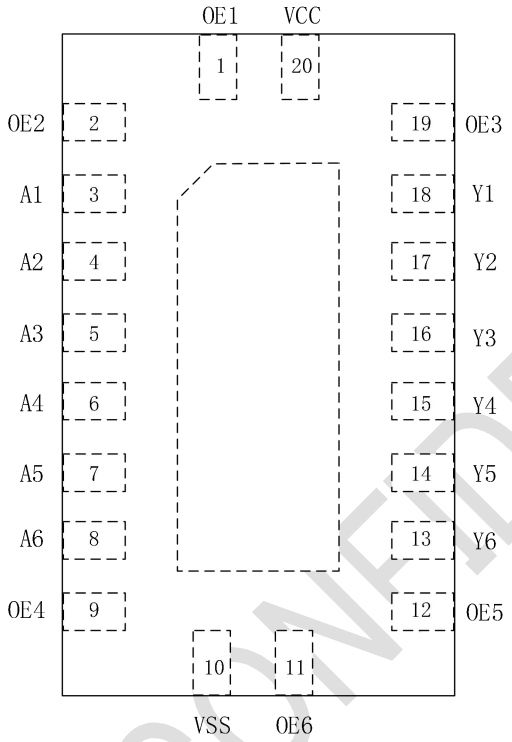

Fig. 2 QFN20 (6-CH) PINOUT (Top View)

4.2. 20-Pin TSSOP

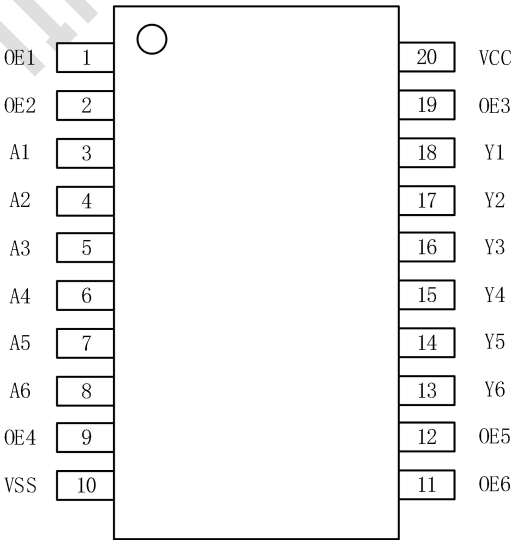

Fig. 3 TSSOP20 (6-CH) PINOUT (Top View)

4.3. 14-Pin TSSOP

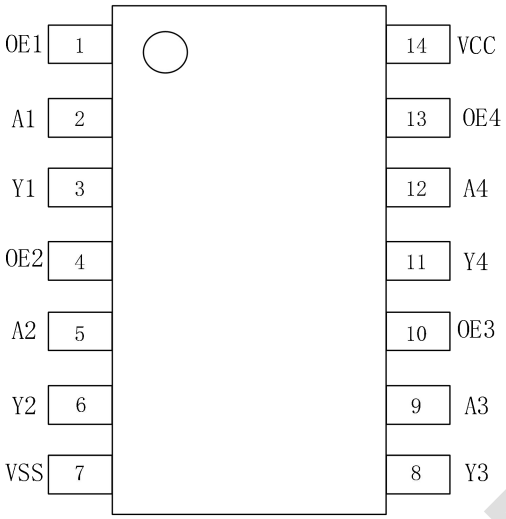

Fig. 4 TSSOP14 (4-CH) PINOUT (Top View)

4.4. PIN Functions

Table 1 PIN functions

QFN20	TSSOP20	TSSOP14	Pin Name	Property	Description
20	20	14	VCC	P	Power supply
10	10	7	VSS	P	Ground
1	1	1	OE1	Input	Channel1, Output Enable, Active High
3	3	2	A1	Input	Channel1, Input A
18	18	3	Y1	Output	Channel1, Output Y
2	2	4	OE2	Input	Channel2, Output Enable, Active High
4	4	5	A2	Input	Channel2, Input A
17	17	6	Y2	Output	Channel2, Output Y
19	19	10	OE3	Input	Channel3, Output Enable, Active High
5	5	9	A3	Input	Channel3, Input A
16	16	8	Y3	Output	Channel3, Output Y
9	9	13	OE4	Input	Channel4, Output Enable, Active High
6	6	12	A4	Input	Channel4, Input A
15	15	11	Y4	Output	Channel4, Output Y
12	12	-	OE5	Input	Channel5, Output Enable, Active High
7	7	-	A5	Input	Channel5, Input A
14	14	-	Y5	Output	Channel5, Output Y
11	11	-	OE6	Input	Channel6, Output Enable, Active High
8	8	-	A6	Input	Channel6, Input A
13	13	-	Y6	Output	Channel6, Output Y

5. Electrical Characteristics

5.1. Absolute Maximum Rating

Table 2 Absolute Maximum Rating

Symbol	Parameter	Min.	Max.	Units
Tj	Junction operating temperature	-55	150	°C
VCC	Supply voltage	-0.5	6.5	V
I_{IK}	Input Clamp Current (VI<0 or VI>VCC) (Fig 3)	-20	20	mA
I_{OK}	Output Clamp Current (VO<0 or VO>VCC) (Fig 3.)	-20	20	mA
I_{OUT}	Continuous Output current (Fig 5)	-45	45	mA
I_{VCC} or I_{VSS}	Continuous current through VCC to VSS	-100	100	mA
V_{HBM}	Human Body Model ESD (1)	-2K	2K	V
V_{CDM}	Charged Device Model ESD (1)	-2K	2K	V
I_{LAT}	Latch Up current	-100	100	mA

Note: Stresses beyond those listed in this section may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

(1) HBM tested to EIA/JESD22−A114−A. CDM tested to JESD22−C101−A.

(2) Latch up tested to EIA/JESD78 Class II

5.2. Recommended Operation Conditions

Table 3 Recommended Operation Conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
T_A	Ambient temperature	-40		125	°C
VCC	Supply voltage	1.65	3.3/5	5.5	V
V_{IN}	Digital Input Voltage	0		VCC	V
V_{OUT}	Digital Output Voltage	0		VCC	V
T_{PU}	VCC Power Up Rate	0		1	V/us

5.3. DC Electrical Characteristics

Table 4 DC Electrical Characteristics

Sym	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{T+}	Positive switching threshold (Fig. 6)	VCC=1.65V	0.9	1.12	1.3	V
		VCC=3.3V	2	2.15	2.3	V
		VCC=5V	3	3.18	3.3	V
		VCC=5.5V	3.3	3.47	3.6	V
V_{T-}	Negative switching threshold	VCC=1.65V	0.2	0.43	0.65	V
		VCC=3.3V	0.9	1.07	1.25	V

	(Fig. 6)	VCC=5V	1.55	1.74	1.95	V
		VCC=5.5V	1.75	1.94	2.15	V
V_{HS}	Hysteresis (V_{T+}-V_{T-}) (Fig. 6)	VCC=1.65V	0.5	0.69	1	V
		VCC=3.3V	0.9	1.08	1.2	V
		VCC=5V	1.3	1.44	1.6	V
		VCC=5.5V	1.4	1.53	1.7	V
V_{OH}	High Level Output Voltage (Fig. 6)	VCC=1.65V~5.5V, IOH=100uA	VCC-0.1	VCC-0.01		V
		VCC=1.65V, IOH=1mA	1.3	1.58		V
		VCC=3.3V, IOH=8mA	3	3.12		V
		VCC=5V, IOH=16mA	4.6	4.75		V
		VCC=5.5V, IOH=16mA	5.1	5.26		V
V_{OL}	Low Level Output Voltage (Fig. 6)	VCC=1.65V~5.5V, IOL=-100uA		0.01	0.1	V
		VCC=1.65V, IOL=-1mA		0.02	0.1	V
		VCC=3.3V, IOL=-8mA		0.08	0.2	V
		VCC=5V, IOL=-16mA		0.12	0.3	V
		VCC=5.5V, IOL=-16mA		0.11	0.3	V
I_{IL}	Input Leakage current	V_I=VCC or VSS			1	uA
I_{OZ}	Off state output current	V_O=VCC or VSS			1	uA
I_{VCC}	Supply Current	V_I=VCC or VSS		0.5	5	uA

5.4. AC Electrical Characteristics

Table 5 AC Electrical Characteristics

Sym	Parameter	Conditions	Min.	Typ.	Max.	Unit
T_{PLH}	Rising Edge Propagation Delay, From An to Yn (Fig. 9)	VCC=1.65V	10.2	17.2	38.7	ns
		VCC=3.3V	2.7	4.3	7.2	ns
		VCC=5V	1.9	2.9	4.7	ns
		VCC=5.5V	1.8	2.7	4.4	ns
T_{PHL}	Falling Edge Propagation Delay, From An to Yn (Fig. 9)	VCC=1.65V	7.9	14.9	47.2	ns
		VCC=3.3V	2.0	3.2	5.1	ns
		VCC=5V	1.4	2.1	3.3	ns
		VCC=5.5V	1.3	2.0	3.0	ns
t_r	Rising Edge Transition Time (Yn) (Fig. 8)	VCC=1.65V	3.4	5.8	18.2	ns
		VCC=3.3V	0.9	1.5	2.6	ns
		VCC=5V	0.7	1.1	1.8	ns
		VCC=5.5V	0.7	1.1	1.7	ns
t_f	Falling Edge Transition Time (Yn) (Fig. 8)	VCC=1.65V	1.8	3.0	6.1	ns
		VCC=3.3V	0.6	1.0	1.5	ns
		VCC=5V	0.5	0.7	1.1	ns

		VCC=5.5V	0.5	0.7	1.0	ns
T_{PZL}	Falling Edge Output Enable Time, OEn to Yn (Fig. 10)	VCC=1.65V, RL=2kΩ	5.1	9.4	25.4	ns
		VCC=3.3V, RL=500Ω	1.4	2.2	3.5	ns
		VCC=5V, RL=500Ω	1.0	1.5	2.2	ns
		VCC=5.5V, RL=500Ω	0.9	1.4	2.1	ns
T_{PZH}	Rising Edge Output Enable Time, OEn to Yn (Fig. 10)	VCC=1.65V, RL=2kΩ	10.7	18.1	43.3	ns
		VCC=3.3V, RL=500Ω	2.7	4.4	7.3	ns
		VCC=5V, RL=500Ω	1.9	2.9	4.7	ns
		VCC=5.5V, RL=500Ω	1.8	2.7	4.4	ns
T_{PLZ}	Output Disable Time when Low, OEn to Yn (Fig. 10)	VCC=1.65V, RL=2kΩ	4.1	5.2	8.6	ns
		VCC=3.3V, RL=500Ω	1.2	1.5	2.0	ns
		VCC=5V, RL=500Ω	1.1	1.3	1.7	ns
		VCC=5.5V, RL=500Ω	1.1	1.4	1.7	ns
T_{PHZ}	Output Disable Time when High, OEn to Yn (Fig. 10)	VCC=1.65V, RL=2kΩ	4.2	5.2	6.7	ns
		VCC=3.3V, RL=500Ω	1.2	1.6	2.0	ns
		VCC=5V, RL=500Ω	1.2	1.4	1.8	ns
		VCC=5.5V, RL=500Ω	1.2	1.4	1.7	ns

Other conditions if not specified in above table:

CL=10pF. Input signal transition time is 0.1ns.

5.5. Capacitive Characteristics

Table 6 Capacitive Characteristics

Sym	Parameter	Conditions	Min.	Typ.	Max.	Unit
C_{IN}	Input Capacitance (OEn, An)	VCC=5.5v, VIN=0 or VCC		2.5		pF
C_{OUT}	Output Capacitance (Yn)	VCC=5.5v, VIN=0 or VCC		2.5		pF
C_{VCC}	VCC Capacitance (VCC)	VCC=5.5v		25		pF

6. Detailed Function Description

TCIB04 contains four independent buffers with 3-state outputs. And TCIB06 contains six independent buffers with 3-state outputs. Both input signals (An) and enable signals (OEn) are Schmitt trigger inputs. Each output performs the Boolean function Yn=An when OEn=1.

The function truth table is shown below:

Table 7 The function truth table

Input		Output
OEn	An	Yn
L	x	Z
H	L	L
H	H	H

n = 1,2,3,4 for TCIB04, or n = 1,2,3,4,5,6 for TCIB06

7. Parameter Definition

7.1. Input/Output Clamp Current

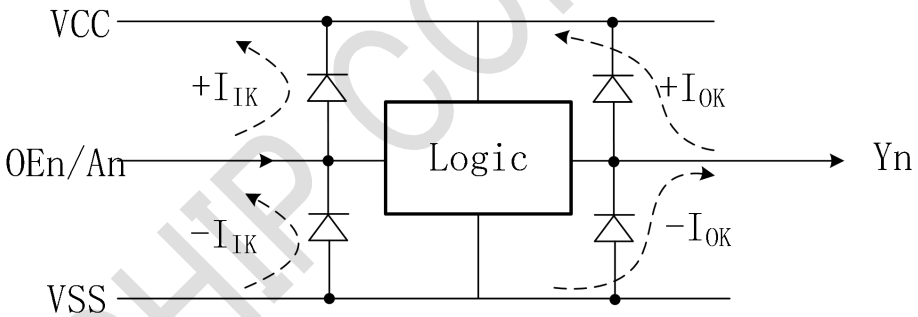

Fig 5. Input/Output Clamp Current

All the input and output pins of this device have the parasitic ESD diode to VCC and VSS. It will have sink or source current when the signal is higher than VCC or lower than VSS no matter the buffer is enabled or disabled. It may damage the device if the sink or source current is big and sustains a period of time. So that it's forbidden when the input/output clamp current exceeds the absolute maximum ratings in table 1.

Please be noted that when VCC is off, if the input is still high, the signal will supply VCC through the upper diode so that it will cause leakage from the previous driver.

7.2. Switching Threshold Voltage

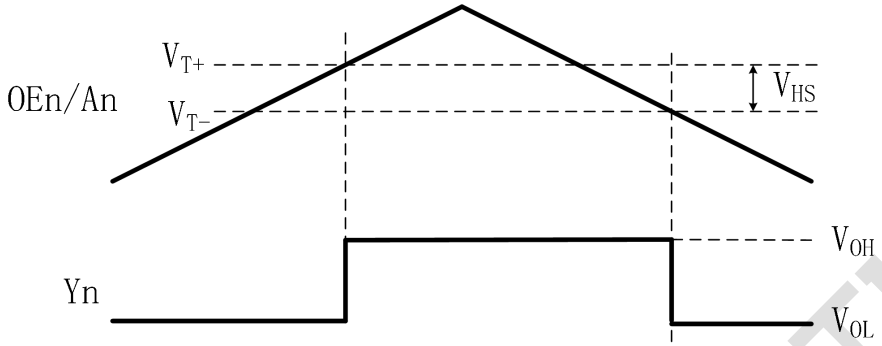

Fig 6. Switching Threshold Voltage

7.3. Output Current

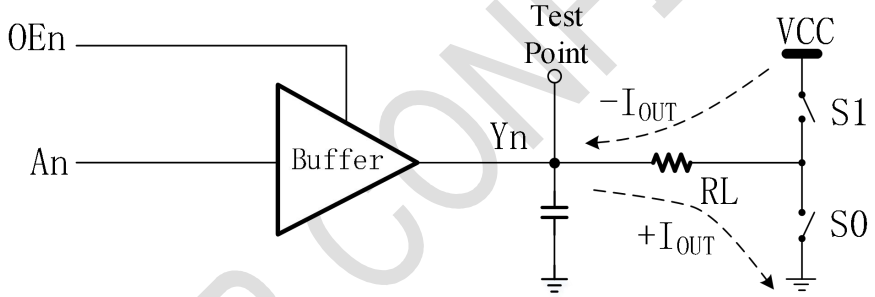

Fig 7. Sink/Source Output Current

7.4. Transition Time

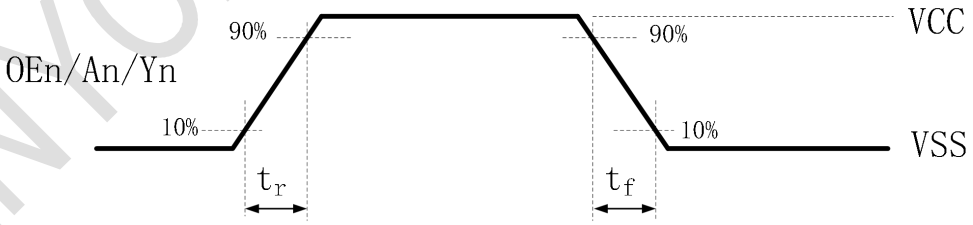

Fig 8. Transition Time

7.5. Propagation Delay Time

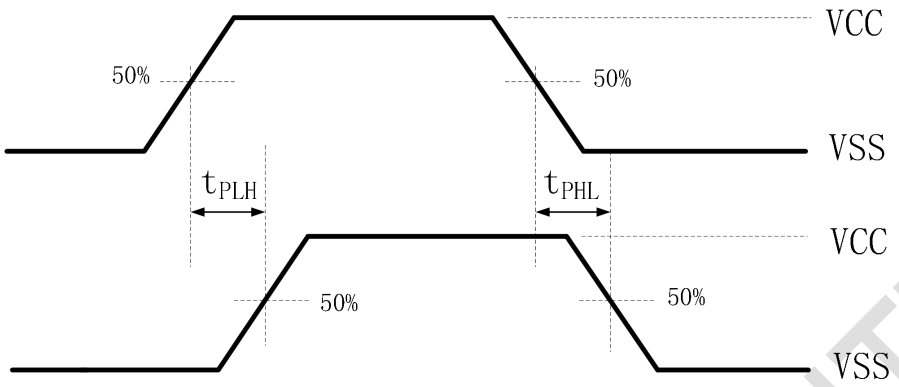

Fig 9. Propagation Delay Time

7.6. Enable/Disable Time

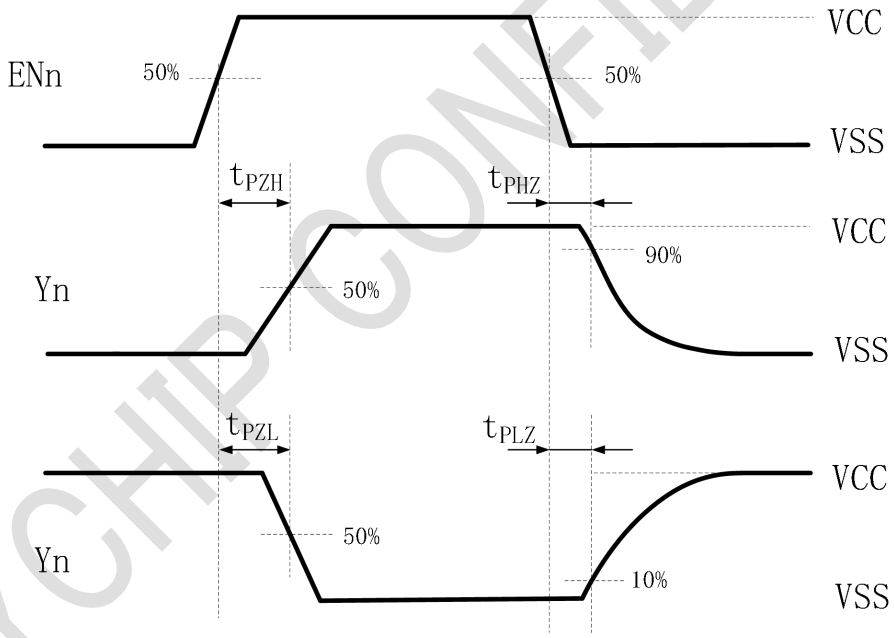

Fig 10. Enable/Disable Time

Note:

1)When t_{PHZ} is measured, RL should be connected, S1/S0=0/1, An=1

2)When t_{PLZ} is measured, RL should be connected, S1/S0=1/0, An=0

8. Package and Carrier Information

8.1. Package Drawing

TBD

8.2. Carrier Materials Information

TBD

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Revision

Revision	Date	Comments
0.1	2022.3.7	Initial revision

About US

Tinychip Microelectronics Co., Ltd. was established in Zhangjiang, Shanghai in 2019. As a leading supplier of high-performance dedicated SoC IC in China, the company focuses on the research and development of various chips related to Internet of Things applications, and has received firm and powerful support as well as investments from selected top investment institutions. The company is joined with a group of top semiconductor experts and is committed to developing into a platform company in semiconductor industry. The team has the research and development capabilities of various system-level complex IC products, and the total shipments have reached billions of units. The company has developed a large number of SoC IC based solutions in analog signal chain, power supply and radio frequency, which cover consumer electronics, industrial control and automotive applications. While setting the industry's new benchmarks with differentiated IC products, they will empower more IoT companies and better serve customer needs.

Tinychip Microelectronics Co., Ltd.

Address: Room 602, Block A, Building 1, No. 800, Naxian Road, Pudong New Area, Shanghai
Room 508, Building 1, Tiansu Technology Park, 170-1 Software Avenue, Yuhuatai District, Nanjing
Website：http://www.tinychip.com.cn

Technical Support

Email：support@tinychip.com.cn