

TC7MA541FK

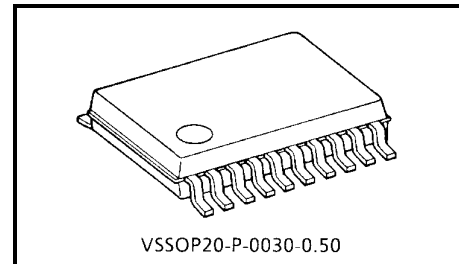
Low-Voltage Octal Bus Buffer with 3.6 V Tolerant Inputs and Outputs

The TC7MA541FK is a high performance CMOS octal bus buffer which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5V, 1.8 V, 2.5 V or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

The device is a non-inverting 3-state buffer having two active-low output enables. When either $\overline{OE}1$ or $\overline{OE}2$ are high, the terminal outputs are in the high-impedance state. This device is designed to be used with 3-state memory address drivers, etc.

All inputs are equipped with protection circuits against static discharge.



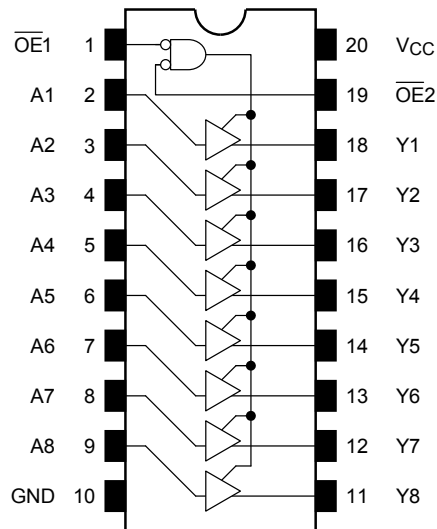
VSSOP20-P-0030-0.50

Weight: 0.03 g (typ.)

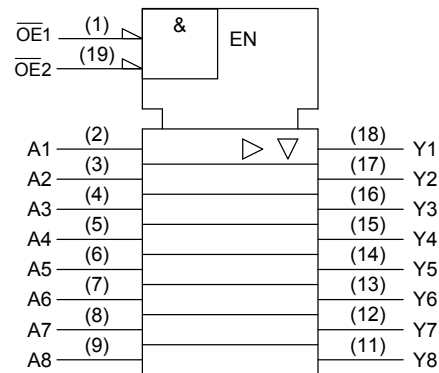
Features

- Low voltage operation: $V_{CC} = 1.2\sim 3.6\text{ V}$
- High speed operation: $t_{pd} = 3.5\text{ ns (max) (}V_{CC} = 3.0\sim 3.6\text{ V)}$
 $t_{pd} = 4.2\text{ ns (max) (}V_{CC} = 2.3\sim 2.7\text{ V)}$
 $t_{pd} = 8.4\text{ ns (max) (}V_{CC} = 1.65\sim 1.95\text{ V)}$
 $t_{pd} = 16.8\text{ ns (max) (}V_{CC} = 1.4\sim 1.6\text{ V)}$
 $t_{pd} = 42.0\text{ ns (max) (}V_{CC} = 1.2\text{ V)}$
- 3.6 V tolerant inputs and outputs.
- Output current: $I_{OH}/I_{OL} = \pm 24\text{ mA (min) (}V_{CC} = 3.0\text{ V)}$
 $I_{OH}/I_{OL} = \pm 18\text{ mA (min) (}V_{CC} = 2.3\text{ V)}$
 $I_{OH}/I_{OL} = \pm 6\text{ mA (min) (}V_{CC} = 1.65\text{ V)}$
 $I_{OH}/I_{OL} = \pm 2\text{ mA (min) (}V_{CC} = 1.4\text{ V)}$
- Latch-up performance: -300 mA
- ESD performance: Machine model $\geq \pm 200\text{ V}$
Human body model $\geq \pm 2000\text{ V}$
- Package: VSSOP (US)
- Power down protection is provided on all inputs and outputs.

Pin Assignment (top view)



IEC Logic Level



Truth Table

Inputs			Outputs
$\overline{OE1}$	$\overline{OE2}$	A_n	
H	X	X	Z
X	H	X	Z
L	L	H	H
L	L	L	L

X: Don't care

Z: High impedance

Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	-0.5~4.6	V
DC input voltage	V_{IN}	-0.5~4.6	V
DC output voltage	V_{OUT}	-0.5~4.6 (Note 2)	V
		-0.5~ $V_{CC} + 0.5$ (Note 3)	
Input diode current	I_{IK}	-50	mA
Output diode current	I_{OK}	± 50 (Note 4)	mA
DC output current	I_{OUT}	± 50	mA
Power dissipation	P_D	180	mW
DC V_{CC} /ground current	I_{CC}/I_{GND}	± 100	mA
Storage temperature	T_{stg}	-65~150	$^{\circ}C$

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: $V_{CC} = 0$ V

Note 3: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Operating Ranges (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	1.2~3.6	V
Input voltage	V_{IN}	-0.3~3.6	V
Output voltage	V_{OUT}	0~3.6 (Note 2)	V
		0~ V_{CC} (Note 3)	
Output current	I_{OH}/I_{OL}	± 24 (Note 4)	mA
		± 18 (Note 5)	
		± 6 (Note 6)	
		± 2 (Note 7)	
Operating temperature	T_{opr}	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note 8)	ns/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either V_{CC} or GND.

Note 2: Off-state

Note 3: High or low state

Note 4: $V_{CC} = 3.0\sim 3.6$ V

Note 5: $V_{CC} = 2.3\sim 2.7$ V

Note 6: $V_{CC} = 1.65\sim 1.95$ V

Note 7: $V_{CC} = 1.4\sim 1.6$ V

Note 8: $V_{IN} = 0.8\sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics ($T_a = -40\sim 85^\circ\text{C}$, $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit		
Input voltage	High level	V_{IH}	—	2.7~3.6	2.0	—	V	
	Low level	V_{IL}	—	2.7~3.6	—	0.8		
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100\ \mu\text{A}$	2.7~3.6	$V_{CC} - 0.2$	—	V
				$I_{OH} = -12\ \text{mA}$	2.7	2.2	—	
				$I_{OH} = -18\ \text{mA}$	3.0	2.4	—	
				$I_{OH} = -24\ \text{mA}$	3.0	2.2	—	
	Low level	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100\ \mu\text{A}$	2.7~3.6	—	0.2	
				$I_{OL} = 12\ \text{mA}$	2.7	—	0.4	
				$I_{OL} = 18\ \text{mA}$	3.0	—	0.4	
				$I_{OL} = 24\ \text{mA}$	3.0	—	0.55	
Input leakage current	I_{IN}	$V_{IN} = 0\sim 3.6$ V	2.7~3.6	—	± 5.0	μA		
3-state output off-state current	I_{OZ}	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0\sim 3.6$ V	2.7~3.6	—	± 10.0	μA		
Power off leakage current	I_{OFF}	$V_{IN}, V_{OUT} = 0\sim 3.6$ V	0	—	10.0	μA		
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	2.7~3.6	—	20.0	μA		
		$V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6$ V	2.7~3.6	—	± 20.0			
	ΔI_{CC}	$V_{IH} = V_{CC} - 0.6$ V (per input)	2.7~3.6	—	750			

DC Characteristics (Ta = -40~85°C, 2.3 V ≤ VCC ≤ 2.7 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		2.3~2.7	1.6	—	V
	Low level	V _{IL}	—		2.3~2.7	—	0.7	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.3~2.7	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	2.3	2.0	—	
				I _{OH} = -12 mA	2.3	1.8	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.3~2.7	—	0.2	
				I _{OL} = 12 mA	2.3	—	0.4	
				I _{OL} = 18 mA	2.3	—	0.6	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		2.3~2.7	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		2.3~2.7	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.3~2.7	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.3~2.7	—	±20.0	

DC Characteristics (Ta = -40~85°C, 1.65 V ≤ VCC < 2.3 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.65~2.3	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.65~2.3	—	0.2 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.65~2.3	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	1.65	1.25	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.65~2.3	—	0.2	
				I _{OL} = 6 mA	1.65	—	0.3	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		1.65~2.3	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		1.65	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.65~2.3	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.65~2.3	—	±20.0	

DC Characteristics (Ta = -40~85°C, 1.4 V ≤ VCC < 1.65 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.4~1.65	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.4~1.65	—	0.05 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.4~1.65	V _{CC} - 0.2	—	V
				I _{OH} = -2 mA	1.4	1.05	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.4~1.65	—	0.05	
				I _{OL} = 2 mA	1.4	—	0.35	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		1.4~1.65	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		1.4~1.65	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.4~1.65	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.4~1.65	—	±20.0	

DC Characteristics (Ta = -40~85°C, 1.2 V ≤ VCC < 1.4 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.2~1.4	0.8 × V _{CC}	—	V
	Low level	V _{IL}	—		1.2~1.4	—	0.05 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.2	V _{CC} - 0.1	—	V
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.2	—	0.05	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		1.2	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V		1.2	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.2	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.2	—	±20.0	

AC Characteristics (Ta = -40~85°C, Input: tr = tf = 2.0 ns)

Characteristics	Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time	tpLH tpHL	Figure 1, Figure 2	CL = 15 pF, RL = 2 kΩ	1.2	1.5	42.0	ns
				1.5 ± 0.1	1.0	16.8	
	CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	1.5	8.4			
		2.5 ± 0.2	0.8	4.2			
3-state output enable time	tpZL tpZH	Figure 1, Figure 3	CL = 15 pF, RL = 2 kΩ	1.2	1.5	49.0	ns
				1.5 ± 0.1	1.0	19.6	
	CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	1.5	9.8			
		2.5 ± 0.2	0.8	5.5			
3-state output disable time	tpLZ tpHZ	Figure 1, Figure 3	CL = 15 pF, RL = 2 kΩ	1.2	1.5	32.5	ns
				1.5 ± 0.1	1.0	13.0	
	CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	1.5	6.5			
		2.5 ± 0.2	0.8	3.6			
Output to output skew	tosLH tosHL	(Note)	CL = 15 pF, RL = 2 kΩ	1.2	—	1.5	ns
				1.5 ± 0.1	—	1.5	
	CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	—	0.5			
		2.5 ± 0.2	—	0.5			
				3.3 ± 0.3	—	0.5	

For CL = 50 pF, add approximately 300 ps to the AC maximum specification.

Note: This parameter is guaranteed by design.

$$(tosLH = |tpLHm - tpLHn|, tosHL = |tpHLm - tpHLn|)$$

Dynamic Switching Characteristics (Ta = 25°C, Input: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition		VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V	(Note)	1.8	0.25	V
				2.5	0.6	
				3.3	0.8	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V	(Note)	1.8	-0.25	V
				2.5	-0.6	
				3.3	-0.8	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V	(Note)	1.8	1.5	V
				2.5	1.9	
				3.3	2.2	

Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

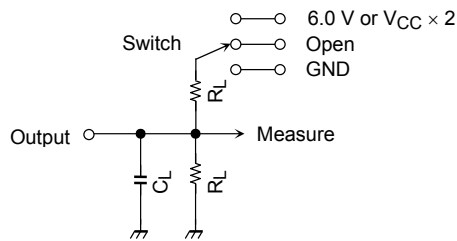
Characteristics	Symbol	Test Condition	V _{CC} (V)	Typ.	Unit
			1.8, 2.5, 3.3		
Input capacitance	C _{IN}	—	1.8, 2.5, 3.3	6	pF
Output capacitance	C _O	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note)	1.8, 2.5, 3.3	20	pF

Note: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per bit)}$$

AC Test Circuit



Parameter	Switch
t _{pLH} , t _{pHL}	Open
t _{pLZ} , t _{pZL}	6.0 V V _{CC} × 2 @V _{CC} = 3.3 ± 0.3 V @V _{CC} = 2.5 ± 0.2 V @V _{CC} = 1.8 ± 0.15 V @V _{CC} = 1.5 ± 0.1 V @V _{CC} = 1.2 V
t _{pHZ} , t _{pZH}	GND

Symbol	V _{CC}	
		3.3 ± 0.3 V 2.5 ± 0.2 V 1.8 ± 0.15 V
R _L	500Ω	2kΩ
C _L	30pF	15pF

Figure 1

AC Waveform

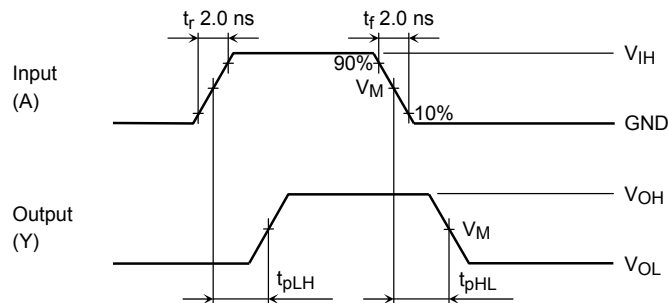


Figure 2 t_{pLH}, t_{pHL}

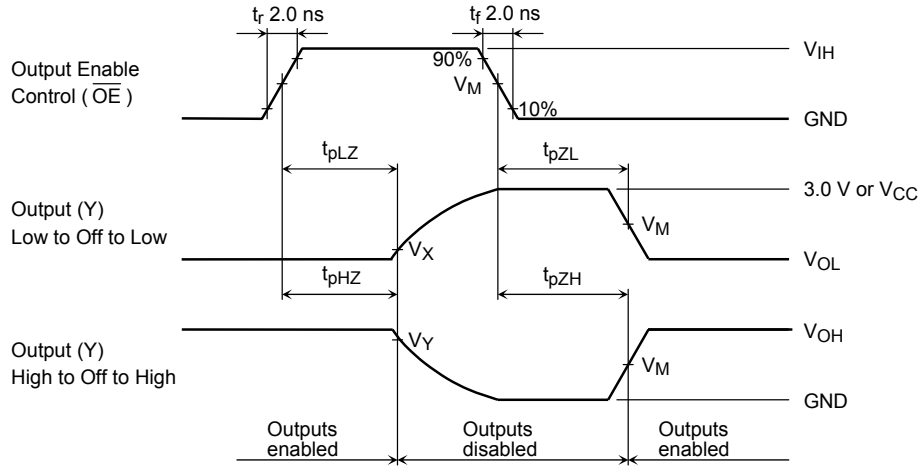


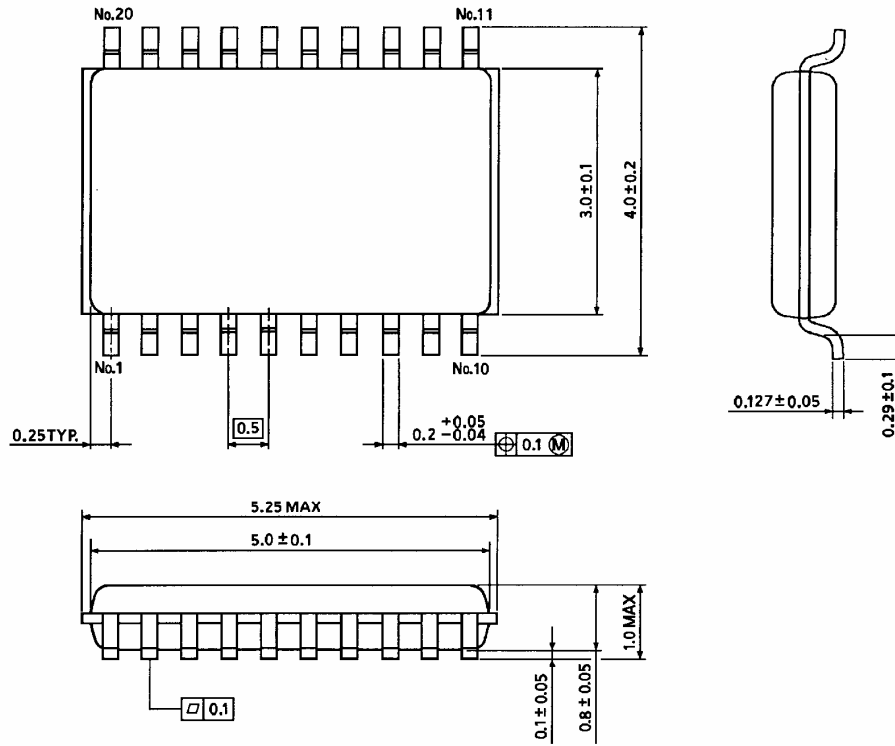
Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

Symbol	V_{CC}				
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 ± 0.15 V	1.5 ± 0.1 V	1.2 V
V_{IH}	2.7 V	V_{CC}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.1$ V	$V_{OL} + 0.1$ V
V_Y	$V_{OH} - 0.3$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.1$ V	$V_{OH} - 0.1$ V

Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



Weight: 0.03 g (typ.)

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20070701-EN GENERAL

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