

Micropower dual CMOS voltage comparators



D SO8

(plastic micropackage)



TSSOP8

(thin shrink small outline package)



S MiniSO8 (plastic package)



DFN8 2x2 mm (plastic micropackage)

Product status link

TSX3702

Related products

See TSX393

for open drain output products

Features

- Low supply current: 5 μA typ. per comparator
- Wide single supply range 2.7 V to 16 V or dual supplies (±1.35 V to ±8 V)
- Extremely low input bias current: 1 pA typ.
- · Input common-mode voltage range includes ground
- Push-pull output
- High input impedance: 10¹² Ω typ
- Fast response time: 2.7 µs typ. for 5 mV overdrive
- ESD tolerance: 4 kV HBM, 200 V MM

Applications

- Automotive
- Industrial

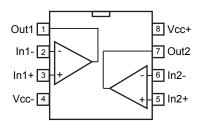
Description

The TSX3702 is a micropower CMOS dual voltage comparator which exhibits a very low current consumption of 5 μA typical per comparator. This device was designed as the improvement of the TS3702: it shows a lower current consumption, a better input offset voltage, and an enhanced ESD tolerance. The TSX3702 is fully specified over a wide temperature range and is proposed in automotive grade for the SO8 package. It is fully compatible with the TS3702 CMOS comparator and is available with similar packages. New tiny packages (MiniSO8 and DFN8 2x2 mm) are also proposed for the TSX3702 thus allowing even more integration on applications.



Package pin connections

Figure 1. Pin connections top view



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2 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

Symbol	Param	eter	Value	Unit
V _{CC} ⁺	Supply voltage ⁽¹⁾		18	
V _{id}	Differential input voltage(2)		±18	V
V _{in}	Input voltage		-0.3 to 18	V
Vo	Output voltage		18	
Io	Output current		20	
I _F	Forward current in ESD pr inputs ⁽³⁾	Forward current in ESD protection diodes on inputs ⁽³⁾		mA
T _j	Maximum junction tempera	ature	150	°C
	SO8	SO8	125	
D., .	Thermal resistance	TSSOP8	120	°C/W
R _{thja}	junction to ambient ⁽⁴⁾	MiniSO8	190	C/VV
		DFN8 2x2	57	
T _{stg}	Storage temperature range	е	-65 to 150	°C
	HBM: human body model	HBM: human body model ⁽⁵⁾		
ESD	MM: machine model ⁽⁶⁾	MM: machine model ⁽⁶⁾ CDM: charged device model ⁽⁷⁾		V
	CDM: charged device mod			
	Latch-up immunity		200	mA

- 1. All voltage values, except differential voltage, are with respect to network ground terminal.
- 2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- 3. Guaranteed by design
- 4. Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
- 5. According to JEDEC standard JESD22-A114F
- 6. According to JEDEC standard JESD22-A115A
- 7. According to ANSI/ESD STM5.3.1

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3 Operating conditions

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V _{CC} +	Supply voltage	2.7 to 16	
V _{icm} ⁽¹⁾	Common mode input voltage range	0 to V _{CC} + - 1.5	V
	$T_{min} \le T_{amb} \le T_{max}$	0 to V _{CC} + - 2	
T _{oper}	Operating free-air temperature range	-40 to 125	°C

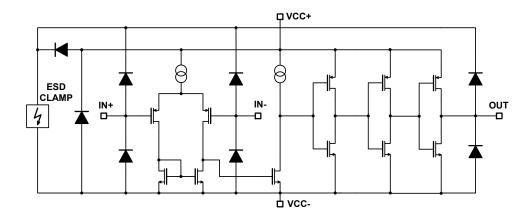
^{1.} The output state is guaranteed as long as one input remains with this common mode input voltage range, and the other input remains between -0.3 V and 16 V (meaning that one input can be driven above VCC+).

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4 Schematic diagram

Figure 2. Schematic diagram (one operator)



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5 Electrical characteristics

Table 3. V_{CC} ⁺ = 3 V, V_{CC} ⁻ = 0 V, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
\/.	land offer to the (4)	V _{icm} = 0 V	-5	0.1	5	
V_{io}	Input offset voltage ⁽¹⁾	$T_{min} \le T_{amb} \le T_{max}$	-6		6	mV
		V _{icm} = V _{CC} /2		1	10	
I _{io}	Input offset current (2)	$T_{min} \le T_{amb} \le T_{max}$			600	
	(0)	V _{icm} = V _{CC} /2		1	10	рA
I _{ib}	Input bias current ⁽²⁾	$T_{min} \le T_{amb} \le T_{max}$			1200	
ONE	Common-mode rejection	V _{icm} = 0 to max V _{icm}	58	73		
CMR	ratio	$T_{min} \le T_{amb} \le T_{max}$	55			
0) (D	Supply voltage rejection	$V_{CC}^{+} = 3 \text{ V to 5 V}, V_{icm} = V_{CC}/2$	69	88		dB
SVR	ratio	$T_{min} \le T_{amb} \le T_{max}$	69			
.,	High-level output voltage	V _{id} = 1 V, I _{OH} = 4 mA		300	400	
V _{OH}	drop	$T_{min} \le T_{amb} \le T_{max}$			600	.,
	Low-level output voltage	V _{id} = -1 V, I _{OL} = 4 mA		300	400	mV
V_{OL}		$T_{min} \le T_{amb} \le T_{max}$			600	
		No load, outputs low		5	6	
	Supply current per	$T_{min} \le T_{amb} \le T_{max}$			7	
I _{CC}	comparator	No load, outputs high		8	9	μA
		$T_{min} \le T_{amb} \le T_{max}$			11	
		V_{icm} = 0 V, f = 10 kHz, R _L = 5.1 k Ω , C _L = 50 pF, overdrive = 5 mV		2.4		
t _{PLH}	Response time low to high	Overdrive = 100 mV		0.5	0.6	
		$T_{min} \le T_{amb} \le T_{max}$			0.77	
		V_{icm} = 0 V, f = 10 kHz, R_L = 5.1 k Ω , C_L = 50 pF, overdrive = 5 mV		2.0		μs
t _{PHL} Response time high to low	Overdrive = 100 mV		0.45	0.6		
		$T_{min} \le T_{amb} \le T_{max}$			0.65	
t _r	Rise time	f = 10 kHz, C_L = 50 pF, R_L = 5.1 k Ω , overdrive 50 mV		39		20
t _f	Fall time	f = 10 kHz, C_L = 50 pF, R_L = 5.1 k Ω , overdrive 50 mV		39		ns

^{1.} The specified offset voltage is the maximum value required to drive the output up to 2.5 V or down to 0.3 V.

Table 4. V_{CC} ⁺ = 5 V, V_{CC} ⁻ = 0 V, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
V _{io}	V (1)	V _{icm} = V _{CC} /2	-5	0.1	5	mV
V IO	Input offset voltage (1)	$T_{min} \le T_{amb} \le T_{max}$	-6		6	IIIV

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^{2.} Guaranteed by design



Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
		V _{icm} = V _{CC} /2		1	10	
I _{io}	Input offset current (2)	$T_{min} \le T_{amb} \le T_{max}$			600	
	(0)	V _{icm} = V _{CC} /2		1	10	рA
l _{ib}	Input bias current (2)	$T_{min} \le T_{amb} \le T_{max}$			1200	
	Common-mode rejection	V _{icm} = 0 to max V _{icm}	66	85		
CMR	ratio	$T_{min} \le T_{amb} \le T_{max}$	65			-
	Supply voltage rejection	$V_{CC}^{+} = 5 \text{ V to } 10 \text{ V}, V_{icm} = V_{CC}/2$	71	89		dB
SVR	ratio	$T_{min} \le T_{amb} \le T_{max}$	70			
	High-level output voltage	V _{id} = 1 V, I _{OH} = 4 mA		180	250	
V _{OH}	drop	$T_{min} \le T_{amb} \le T_{max}$			400	-
		V _{id} = -1 V, I _{OL} = 4 mA		180	250	mV
V_{OL}	Low-level output voltage	$T_{min} \le T_{amb} \le T_{max}$			400	-
		No load, outputs low		5	8	
	Supply current per	$T_{min} \le T_{amb} \le T_{max}$			9	
I _{CC}	comparator	No load, outputs high		9	10	μA
		$T_{min} \le T_{amb} \le T_{max}$			11	
		V_{icm} = 0 V, f = 10 kHz, R_L = 5.1 k Ω , C_L = 50 pF, overdrive = 5 mV		2.4		
		Overdrive = 10 mV		1.5		
		Overdrive = 20 mV		0.9		-
t _{PLH}	Response time low to	Overdrive = 40 mV		0.6		
	high	Overdrive = 100 mV		0.35	0.55	
		$T_{min} \le T_{amb} \le T_{max}$			0.6	
		TTL input (3)		0.45	0.6	
		$T_{min} \le T_{amb} \le T_{max}$			0.65	
		V_{icm} = 0 V, f = 10 kHz, R_L = 5.1 k Ω , C_L = 50 pF, overdrive = 5 mV		2.8		μs
		Overdrive = 10 mV		1.8		
		Overdrive = 20 mV		1.0		
t _{PHL}	Response time high to low	Overdrive = 40 mV		0.7		
	IOW	Overdrive = 100 mV		0.46	0.6	
	$T_{min} \le T_{amb} \le T_{max}$			0.7		
	TTL input (3)		0.30	0.40		
		$T_{min} \le T_{amb} \le T_{max}$			0.50	
t _r	Rise time	$\label{eq:f_scale} \begin{array}{l} \text{f = 10 kHz, } C_L = 50 \text{ pF, } R_L = 5.1 \text{ k}\Omega, \\ \text{overdrive 50 mV} \end{array}$		30		ne
t _f	Fall time	f = 10 kHz, C_L = 50 pF, R_L = 5.1 kΩ, overdrive 50 mV		30		ns

- 1. The specified offset voltage is the maximum value required to drive the output up to 4.5 V or down to 0.3 V.
- 2. Guaranteed by design
- 3. A step from 0 V to 3 V is applied on one input while the other is fixed at 1.4 V. Response time is the time interval between the application of the input voltage step and the moment the output voltage reaches 50 % of its final value.

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Table 5. V_{CC} ⁺ = 16 V, V_{CC} ⁻ = 0 V, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
V	(1)	V _{icm} = V _{CC} /2	-5	0.1	5	\/
V_{io}	Input offset voltage (1)	$T_{min} \le T_{amb} \le T_{max}$	-6		6	mV
		V _{icm} = V _{CC} /2		1	10	
l _{io}	Input offset current (2)	$T_{min} \le T_{amb} \le T_{max}$			600	
		V _{icm} = V _{CC} /2		1	10	рА
l _{ib}	Input bias current (2)	$T_{min} \le T_{amb} \le T_{max}$			1200	
	Common-mode rejection	V _{icm} = 0 to max V _{icm}	72	90		
CMR	ratio	$T_{min} \le T_{amb} \le T_{max}$	70			
	Supply voltage rejection	$V_{CC}^{+} = 5 \text{ V to } 16 \text{ V}, V_{icm} = V_{CC}/2$	73	90		dB
SVR	ratio	$T_{min} \le T_{amb} \le T_{max}$	72			
	High-level output voltage	V _{id} = 1 V, I _{OH} = 4 mA		90	150	
V_{OH}	drop	$T_{min} \le T_{amb} \le T_{max}$			250	
		V _{id} = -1 V, I _{OL} = 4 mA		90	150	mV
V _{OL}	Low-level output voltage	$T_{min} \le T_{amb} \le T_{max}$			250	
		No load, outputs low		7	9	
	Supply current per	$T_{min} \le T_{amb} \le T_{max}$			10	
I _{CC}	comparator	No load, outputs high		11	13	μA
		$T_{min} \le T_{amb} \le T_{max}$			14	
		V_{icm} = 0 V, f = 10 kHz, R_L = 5.1 k Ω , C_L = 50 pF, overdrive = 5 mV		2.2		
		Overdrive = 10 mV		1.4		
t _{PLH}	Response time low to	Overdrive = 20 mV		0.9		
	high	Overdrive = 40 mV		0.6		
		Overdrive = 100 mV		0.34	0.55	
		$T_{min} \le T_{amb} \le T_{max}$			0.60	116
		V_{icm} = 0 V, f = 10 kHz, R _L = 5.1 k Ω , C _L = 50 pF, overdrive = 5 mV		2.4		μs
		Overdrive = 10 mV		1.6		
t _{PHL}	Response time high to low	Overdrive = 20 mV		1.0		
low	IOW	Overdrive = 40 mV		0.7		
		Overdrive = 100 mV		0.55	0.70	
		$T_{min} \le T_{amb} \le T_{max}$			0.75	
t _r	Rise time	f = 10 kHz, C_L = 50 pF, R_L = 5.1 kΩ, overdrive 50 mV		11		n
t _f	Fall time	f = 10 kHz, C_L = 50 pF, R_L = 5.1 kΩ, overdrive 50 mV		11		ns

^{1.} The specified offset voltage is the maximum value required to drive the output up to $4.5~\mathrm{V}$ or down to $0.3~\mathrm{V}$.

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^{2.} Guaranteed by design



output high 16 $V_{ICM} = V_{CC}/2$ 14 output HIGH no load 12 +125°C 10 (aA) 8 _8 +25°C 6 -40°C 4 2

 $V_{cc}(V)$

14

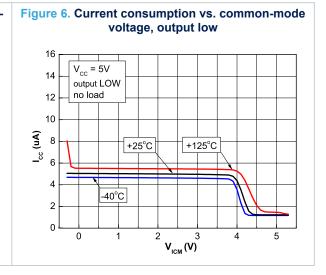
0

Figure 3. Current consumption vs. supply voltage,

output low 12 $V_{ICM} = V_{CC}/2$ output LOW 10 no load 8 +125°C I_{cc} (uA) 6 4 +25°C -40°C 2 0 0 2 4 6 10 12 14 16 V_{cc}(V)

Figure 4. Current consumption vs. supply voltage,

Figure 5. Current consumption vs. input commonmode voltage, output high 16 $V_{CC} = 5V$ 14 output HIGH no load 12 +125°C 10 (aA) 8 _⁸ -40°C +25°C 6 4 2 0 **V**_{ICM} (**V**) 0



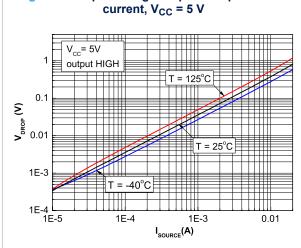
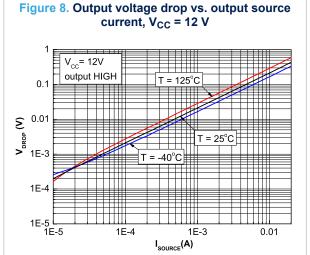


Figure 7. Output voltage drop vs. output source



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current, V_{CC} = 5 V V_{CC}= 5V output LOW T = 125°C 0.1 (S) 0.01 T = 25°C T = -40°C

1E-3

 $I_{SINK}(A)$

0.01

1E-3

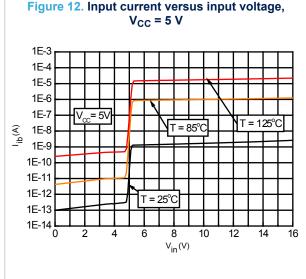
1E-4 1E-5

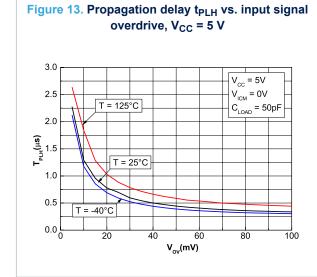
Figure 9. Output voltage drop vs. output sink

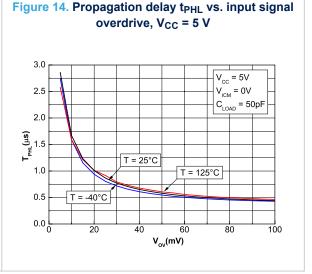
current, V_{CC} = 12 V V_{cc}= 12V output LOW T = 125°C 0.1 € 0.01 1E-5 1E-4 1E-3 0.01 $I_{SINK}(A)$

Figure 10. Output voltage drop vs. output sink

Figure 11. Input offset voltage distribution, $V_{CC} = 5 V$ 30 V_{cc} = 5V 25 $T = 25^{\circ}C$ 20 Population (%) 15 10 5 -4 0 Input offset voltage (mV)







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Figure 15. Propagation delay t_{PLH} vs. supply voltage, V_{CC} = 5 V

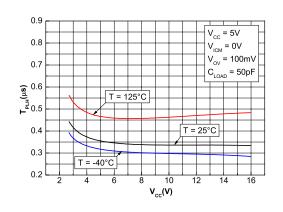
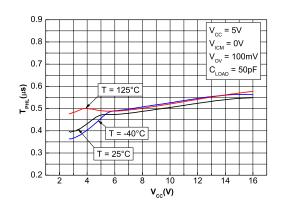


Figure 16. Propagation delay t_{PHL} vs. supply voltage, $V_{CC} = 5 \text{ V}$



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6 Application information (input voltages)

The ESD strategy used in the TSX3702 (and shown in Figure 2. Schematic diagram (one operator) allows input voltages from -0.3 V up to 16 V to be applied regardless of the V_{CC} + voltage. When $V_{IN} > V_{CC}$ + a leakage current goes from the input through the protection diode to the ESD clamp. This current is about 0.2 nA at 25 °C and about 250 nA at 125 °C. For a detailed input characteristic see Section 5 Figure 12. The device is designed to prevent phase reversal.

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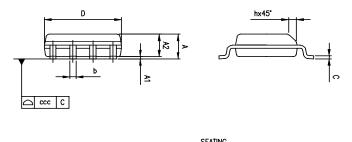


7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

7.1 SO8 package information

Figure 17. SO8 package outline



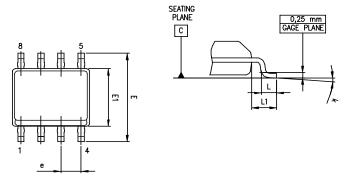


Table 6. SO8 package mechanical data

			Dime	nsions		
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
С	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
е		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	0°		8°	0°		8°
CCC			0.10			0.004

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7.2 TSSOP8 package information

Figure 18. TSSOP8 package outline

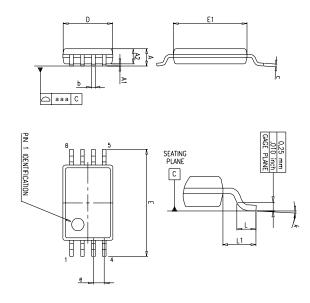


Table 7. TSSOP8 package mechanical data

	Dimensions					
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
А			1.20			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
С	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
е		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa		0.10			0.004	

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7.3 DFN8 2x2 package information

PIN 1 INDEX AREA

BOTTOM VIEW

BOTTOM VIEW

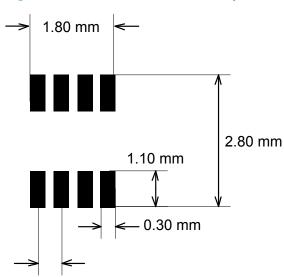
Figure 19. DFN8 2x2 package outline

Table 8. DFN8 2x2 mechanical data

	Dimensions					
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α	0.70	0.75	0.80	0.028	0.030	0.031
A1	0.00	0.02	0.05	0.000	0.001	0.002
b	0.15	0.20	0.25	0.006	0.008	0.010
D		2.00			0.079	
E		2.00			0.079	
е		0.50			0.020	
L	0.045	0.55	0.65	0.018	0.022	0.026
N			-	8		

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0.50 mm

Figure 20. DFN8 2x2 recommended footprint

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7.4 MiniSO8 package information

Figure 21. MiniSO8 package outline

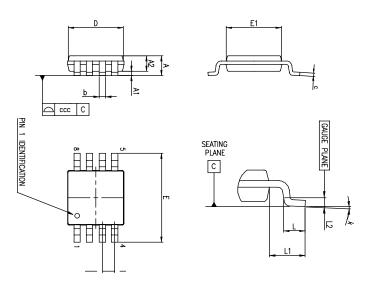


Table 9. MiniSO8 package mechanical data

	Dimensions					
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α			1.1			0.043
A1	0		0.15	0		0.0006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
С	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
е		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

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8 Ordering information

Table 10. Order codes

Order code	Temperature range	Package	Packing	Marking
TSX3702IDT		SO8		SX3702
TSX3702IPT		TSSOP8		S3702
TSX3702IST	-40 °C, 125 °C	MiniSO8	Tape and reel	K532
TSX3702IQ2T	,	DFN8 2x2		K5J
TSX3702IYDT ⁽¹⁾	SO8 (automotive grade)			SX3702Y

Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q002 or equivalent.

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Revision history

Table 11. Document revision history

Date	Revision	Changes
18-Apr-2014	1	Initial release.
13-Feb-2015	2	Table 1: Absolute maximum ratings (AMR): removed footnote associated with Vin. Table 2: Operating conditions: added footnote concerning Vicm. Figure 2: Schematic diagram (one operator): updated
		Table 6: added "L1"
06-Jun-2016	3	Table 3, Table 4, and Table 5: updated several values (l_{io} , l_{ib} , t_{PLH} , and t_{PHL}) and conditions (V_{OH} , V_{OL} , and CMR) Table 10: updated marking of order code TSX3702IPT (now SX3702 instead of 5X3702), updated automotive order code footnote.
15-May-2017	4	Updated automotive footnote in Table 10. Order codes.
02-Sep-2019	5	Updated Section 7.3 DFN8 2x2 package information.
20-Jan-2023	6	Updated figure on the cover page.

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