



钜地半导体
Tudi Semiconductor

Product Specification

TUDI-TS971/TS972/TS974

Output rail-to-rail very low noise operational amplifier

网址 www.sztdbdt.com Q

用芯智造 · 卓越品质

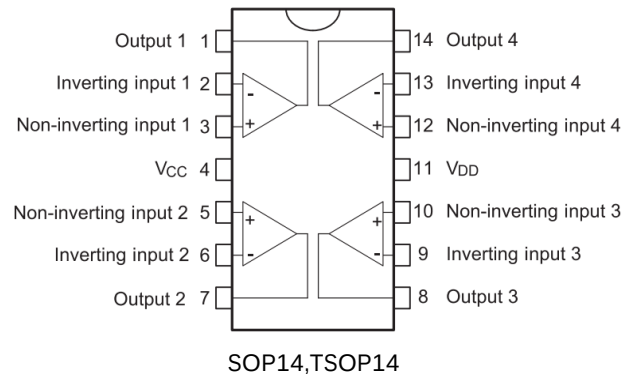
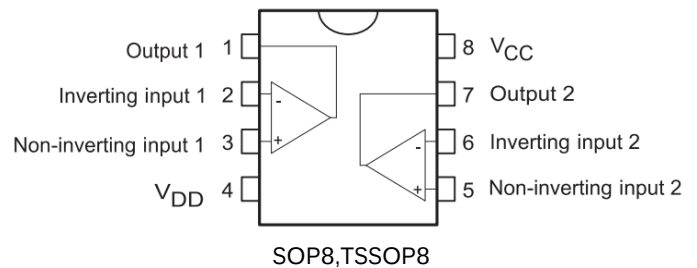
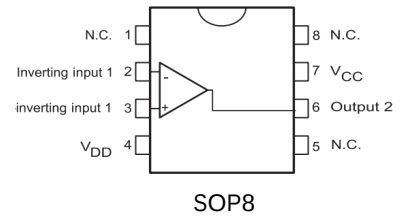
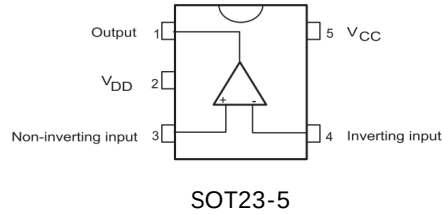
**semiconductor device
manufacturer**

- Design
- research and development
- production
- and sales



Features

- Rail-to-rail output voltage swing ± 2.4 V at $V_{CC} = \pm 2.5$ V
- Very low noise level: $4 \text{ nV}/\sqrt{\text{Hz}}$
- Ultra low distortion: 0.003%
- High dynamic features: 12 MHz , $4 \text{ V}/\mu\text{s}$
- Operating range: 2.7 to 10 V
- ESD protection (2 kV)
- Latch-up immunity (class A)



Applications

- Portable devices (CD players, PDAs)
- Portable communication (cell phones, pagers)
- Instrumentation and sensing
- technology Professional audio circuits

Description

The TS97x family of operational amplifiers operate with voltages as low as $\pm 1.35 \text{ V}$ and feature output rail-to-rail signal swing. The TS97x devices are particularly well suited for portable and battery-supplied equipment. Very low noise and low distortion characteristics make them ideal for audio pre-amplification.

The TS97x devices are available in a variety of packages to suit all types of applications. For applications where space saving is critical, the SOT23-5 package ($2.8 \times 2.9 \text{ mm}$) or the DFN8 package ($3 \times 3 \text{ mm}$) simplify the board design because they can be placed anywhere on it.



2

Absolute maximum ratings and operating conditions

Table 1: Absolute maximum ratings (AMR)

Symbol	Parameter		Value	Unit
V _{CC}	Supply voltage ⁽¹⁾		12	V
V _{id}	Differential input voltage ⁽²⁾		±1	
V _{in}	Input voltage ⁽³⁾		V _{DD} - 0.3 to V _{CC} + 0.3	
T _{stg}	Storage temperature range		-65 to 150	°C
T _j	Maximum junction temperature		150	
R _{thja}	Thermal resistance junction-to-ambient ⁽⁴⁾	SOT23-5	250	°C/W
		SO8	125	
		TSSOP8	120	
		DFN8 3x3	40	
		SO14	105	
		TSSOP14	100	
R _{thjc}	Thermal resistance junction-to-case ⁽⁴⁾	SOT23-5	81	
		SO8	40	
		TSSOP8	37	
		DFN8 3x3	5.2	
		SO14	31	
		TSSOP14	32	
ESD	HBM: human body model ⁽⁵⁾		2	kV
	MM: machine model ⁽⁶⁾		200	V
	CDM: charged device model ^{(7) (8)}		1.5	kV
	Lead temperature (soldering, 10 sec.)		260	°C

Notes:

⁽¹⁾All voltage values, except the differential voltage are with respect to the network ground terminal.

⁽²⁾The differential voltage is the non-inverting input terminal with respect to the inverting input terminal.

⁽³⁾The magnitude of input and output voltages must never exceed V_{CC} + 0.3 V.

⁽⁴⁾Short-circuits can cause excessive heating and destructive dissipation. Values are typical.

⁽⁵⁾Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.

⁽⁶⁾Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.

⁽⁷⁾No value specified for CDM on SOT23-5 package.

⁽⁸⁾Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.



Table 2: Operating conditions

Symbol	Parameter	Value	Unit
V _{CC}	Supply voltage	2.7 to 10	V
V _{icm}	Common mode input voltage range	V _{DD} + 1.15 to V _{CC} - 1.15	
T _{oper}	Operating free air temperature range	-40 to 125	°C

3 Electrical characteristics

**Table 3: Electrical characteristics at V_{CC} = 2.5 V, V_{DD} = -2.5 V, T_{amb} = 25 °C
(unless otherwise specified)**

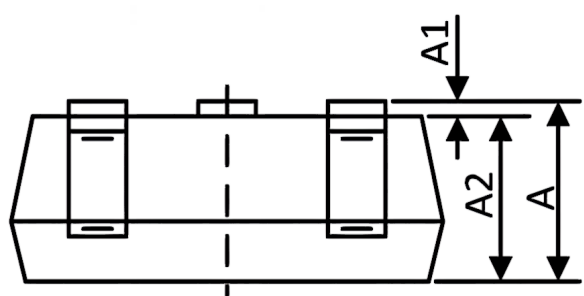
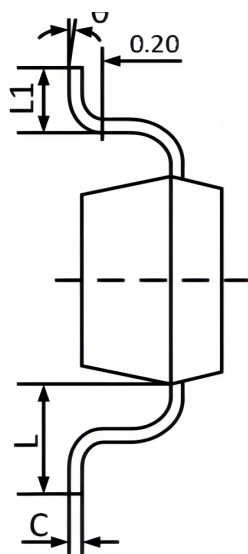
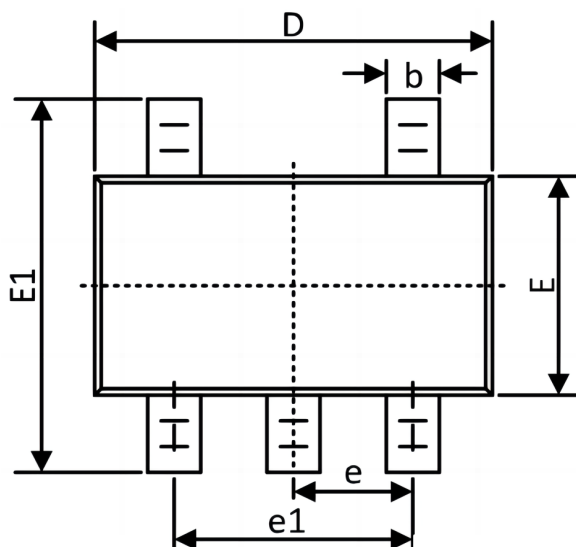
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V _{io}	Input offset voltage			1	5	mV
		T _{min} ≤ T _{amb} ≤ T _{max}			7	
ΔV _{io} /ΔT	Input offset voltage drift	V _{icm} = 0 V, V _o = 0 V		5		μV/°C
I _{io}	Input offset current	V _{icm} = 0 V, V _o = 0 V		10	150	nA
I _{ib}	Input bias current	V _{icm} = 0 V, V _o = 0 V		200	750	
		T _{min} ≤ T _{amb} ≤ T _{max}		200	1000	
V _{icm}	Common mode input voltage range		-1.35		1.35	V
CMR	Common mode rejection ratio	V _{icm} = ±1.35 V	60	85		dB
SVR	Supply voltage rejection ratio	V _{CC} = ±2 V to ±3 V	60	70		
A _{vd}	Large signal voltage gain		70	80		
V _{OH}	High-level output voltage	R _L = 2 kΩ	2	2.4		V
V _{OL}	Low-level output voltage			-2.4	-2	
I _{source}	Output source current			1.5		mA
I _{sink}	Output sink current			100		
I _{CC}	Supply current per amplifier	Unity gain, no load		2	2.8	
GBP	Gain bandwidth product	f = 100 kHz, R _L = 2 kΩ, C _L = 100 pF	8.5	12		MHz
SR	Slew rate	A _v = 1, V _{in} = ±1 V	2.8	4		V/μs
∅ _m	Phase margin at unit gain	R _L = 2 kΩ, C _L = 100 pF		60		Degrees
G _m	Gain margin			10		dB
e _n	Equivalent input noise voltage	f = 100 kHz		4		nV/√Hz
i _n	Equivalent input noise current	f = 1 kHz		250		fA/√Hz
THD	Total harmonic distortion	f = 1 kHz, A _v = -1, R _L = 10 kΩ		0.003		%



Order information

Order Number	Package	Package Quantity	Marking On The park
TS971IDT-TUDI	SOP8	Tape,Reel,2500	TS971IDT
TS971ILT-TUDI	SOT23	Tape,Reel,3000	TS971ILT
TS972IDT-TUDI	SOP8	Tape,Reel,2500	TS972IDT
TS972IPT-TUDI	TSSOP8	Tape,Reel,2500	TS972IPT
TS974IDT-TUDI	SOP8	Tape,Reel,2500	TS974IDT
TS974IPT-TUDI	TSSOP8	Tape,Reel,2500	TS974IPT
TS974IYDT-TUDI	SOP14	Tape,Reel,2500	TS974IYDT
TS974IYPT-TUDI	TSSOP14	Tape,Reel,2500	TS974IYPT

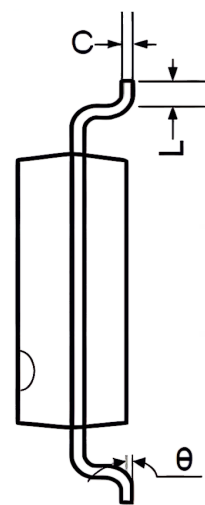
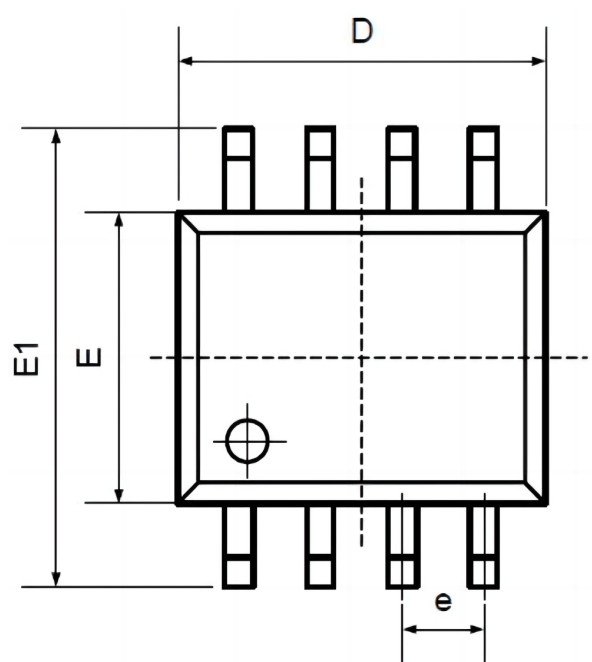
Package SOT23-5



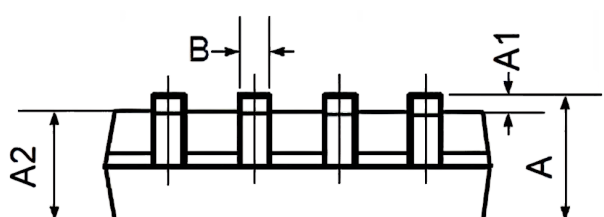
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



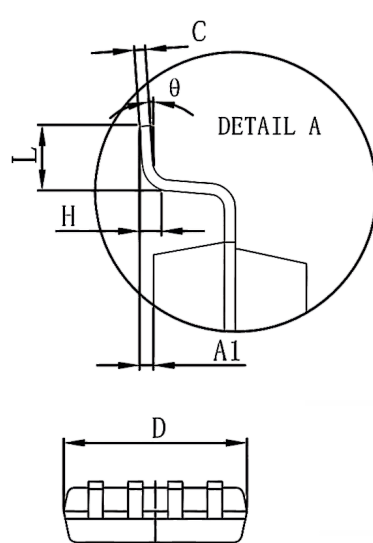
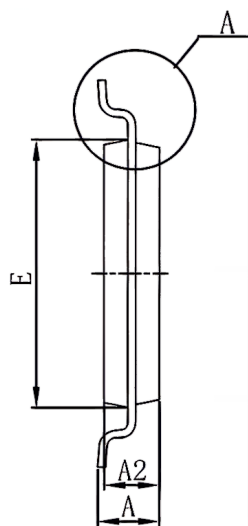
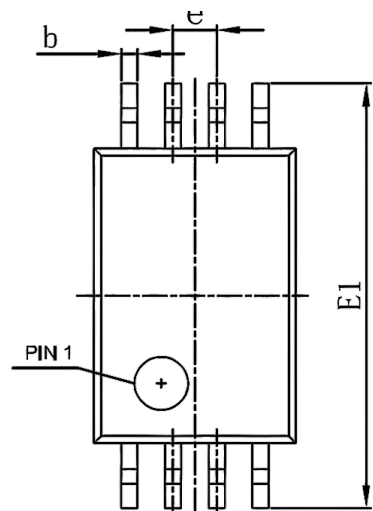
Package SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°



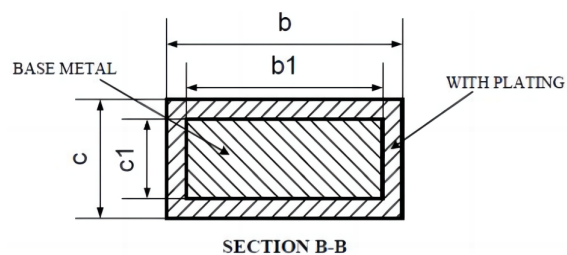
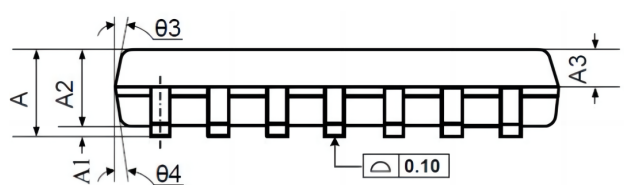
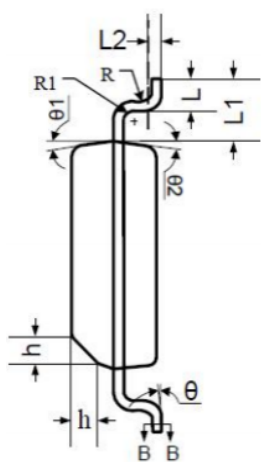
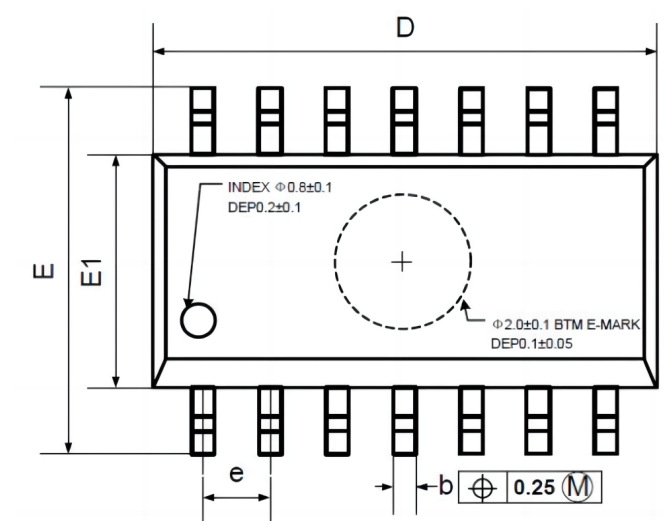
Package TSSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
C	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°		1°	

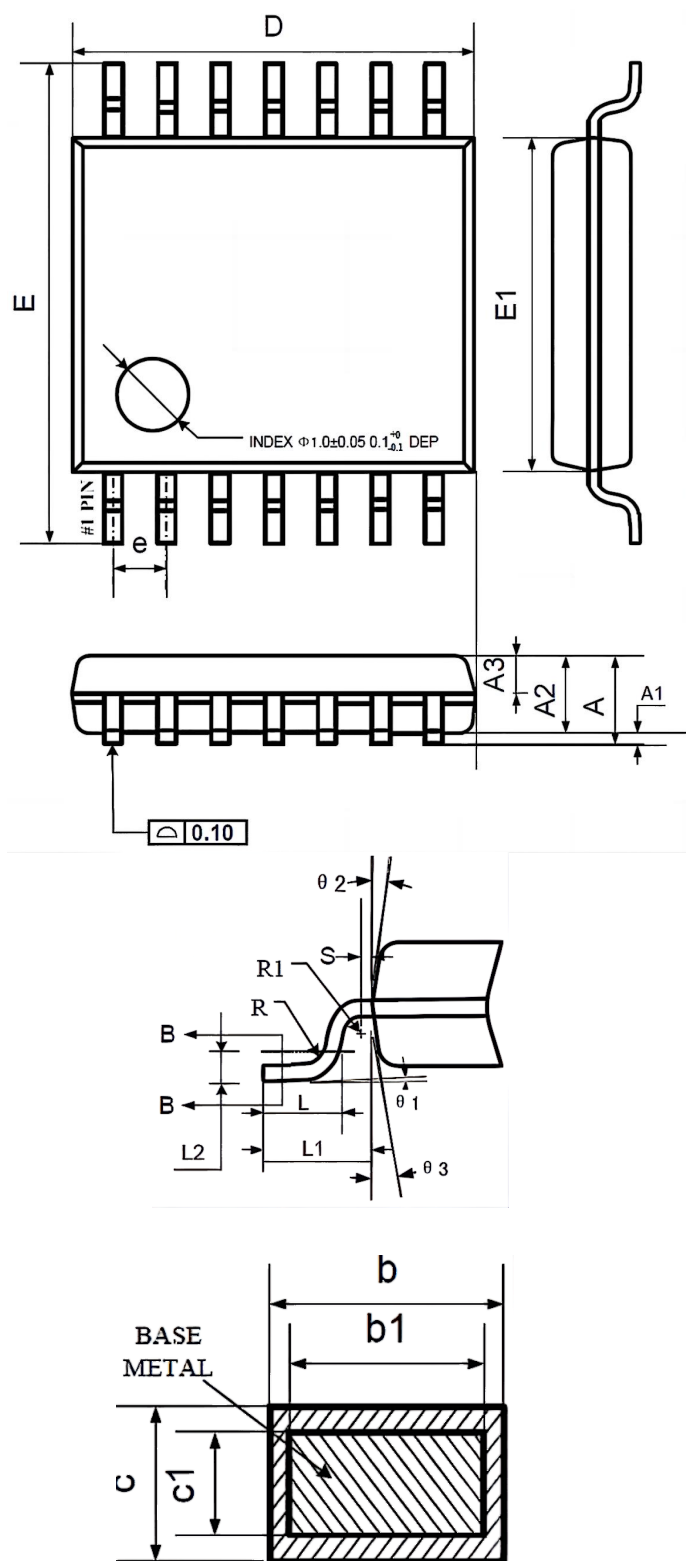


Package SOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
θ1	6°	8°	10°
θ2	6°	8°	10°
θ3	5°	7°	9°
θ4	5°	7°	9°

Package TSSOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	—	0.28
b1	0.20	0.22	0.24
C	0.10	—	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	—	—
R1	0.09	—	—
S	0.20	—	—
$\theta 1$	0°	—	8°
$\theta 2$	10°	12°	14°
$\theta 3$	10°	12°	14°



Important statement:

- TUDI Semiconductor reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.
- Any semi-guide product is subject to failure or malfunction under specified conditions. It is the buyer's responsibility to comply with safety standards when using TUDI Semiconductor products for system design and whole machine manufacturing. And take the appropriate safety measures to avoid the potential in the risk of loss of personal injury or loss of property situation!
- TUDI Semiconductor products have not been licensed for life support, military, and aerospace applications, and therefore TUDI Semiconductor is not responsible for any consequences arising from the use of this product in these areas.
- If any or all TUDI Semiconductor products (including technical data, services) described or contained in this document are subject to any applicable local export control laws and regulations, they may not be exported without an export license from the relevant authorities in accordance with such laws.
- The specifications of any and all TUDI Semiconductor products described or contained in this document specify the performance, characteristics, and functionality of said products in their standalone state, but do not guarantee the performance, characteristics, and functionality of said products installed in Customer's products or equipment. In order to verify symptoms and conditions that cannot be evaluated in a standalone device, the Customer should ultimately evaluate and test the device installed in the Customer's product device.
- TUDI Semiconductor documentation is only allowed to be copied without any alteration of the content and with the relevant authorization. TUDI Semiconductor assumes no responsibility or liability for altered documents.
- TUDI Semiconductor is committed to becoming the preferred semiconductor brand for customers, and TUDI Semiconductor will strive to provide customers with better performance and better quality products.