



钰地半导体
Tudi Semiconductor

Product Specification

TUDI-TLC5615

10-BIT DIGITAL-TO-ANALOG CONVERTERS

网址 www.sztdbdt.com Q

用芯智造 · 卓越品质

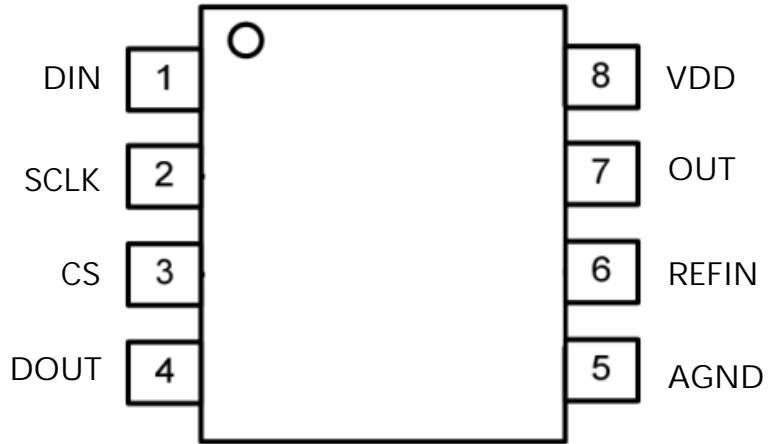
semiconductor device
manufacturer

- Design
- research and development
- production
- and sales



Features

- 5V Single Supply Operation
- 3-Wire Serial Interface
- High-Impedance Reference Inputs
- Internal Power-On Reset
- Low Power Consumption: 1.75mW Max
- Update Rate of 1.21MHz
- Settling Time to 0.5LSB: 12.5 μ s Typ
- Monotonic Over Temperature
- 10-Bit CMOS Voltage Output DAC in an8-Terminal Package
- Voltage Output Range: 2 Times the Reference Input Voltage



Description

The TLC5615 is a 10-bit voltage output digital-to-analog converter (DAC) with a buffered reference input (high impedance). The DAC has an output voltage range that is two times the reference voltage, and the DAC is monotonic. The device is simple to use, running from a single supply of 5V. A power-on-reset function is incorporated to ensure repeatable start-up conditions.

Digital control of the TLC5615 is over a three-wire serial bus that is CMOS compatible and easily interfaced to industry standard microprocessor and microcontroller devices. The device receives a 16-bit data word to produce the analog output. The digital inputs feature Schmitt triggers for high noise immunity. Digital communication protocols include the SPI™, QSPI™, and Microwire™ standards. The 8-terminal small-outline D package allows digital control of analog functions in space-critical applications. The TLC5615C is characterized for operation from 0°C to +70°C. The TLC5615I is characterized for operation from -40°C to +85°C.

Applications

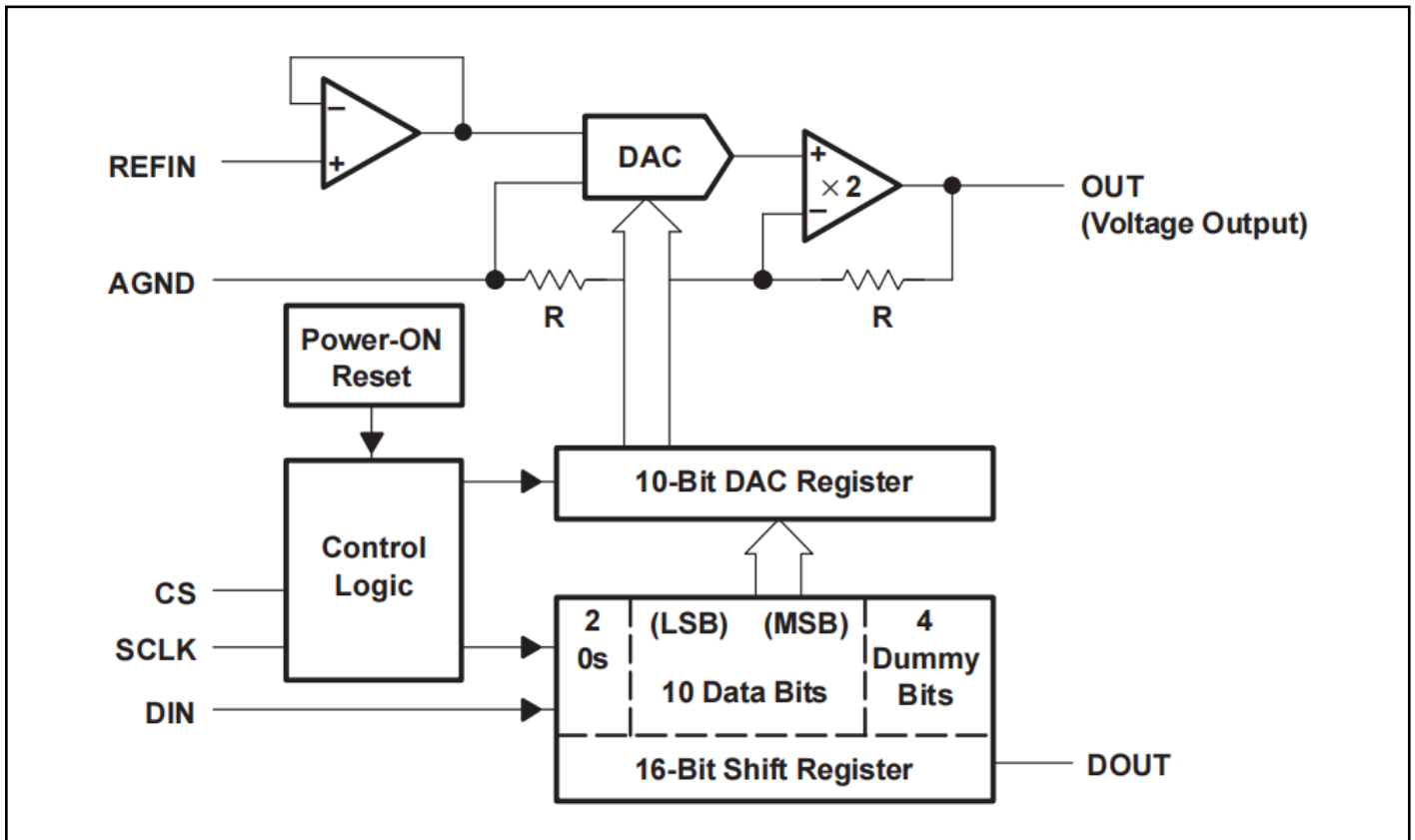
- Battery-Powered Test Instruments
- Digital Offset and Gain Adjustment
- Battery Operated/Remote Industrial Controls
- Machine and Motion Control Devices
- Cellular Telephones



Pin description

Name	No.	IV/O	Description
DIN	1	I	Serial data input
SCLK	2	I	Serial clock input
CS	3	I	Chip select, active low
DOUT	4	O	Serial data output for daisy chaining
AGND	5		Analog ground
REFIN	6	I	Reference input
OUT	7	O	DAC analog voltage output
VDD	8		Positive power supply

Functional block diagram





Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		UNIT
Supply voltage (VoD to AGND)		7V
Digital input voltage range to AGND		-0.3V to VDD+0.3V
Reference input voltage range to AGND		-0.3V to VDD+0.3V
Output voltage at OUT from external source		VDD+0.3V
Continuous current at any terminal		±20mA
Operating free-air temperature range,TA	TLC5615C	0 to+70
	TLC5615I	-40 to +85
Storage temperature range,Tstg		-65 to+150
Lead temperature 1,6mm(1/16 inch)from case for 10 seconds		+260

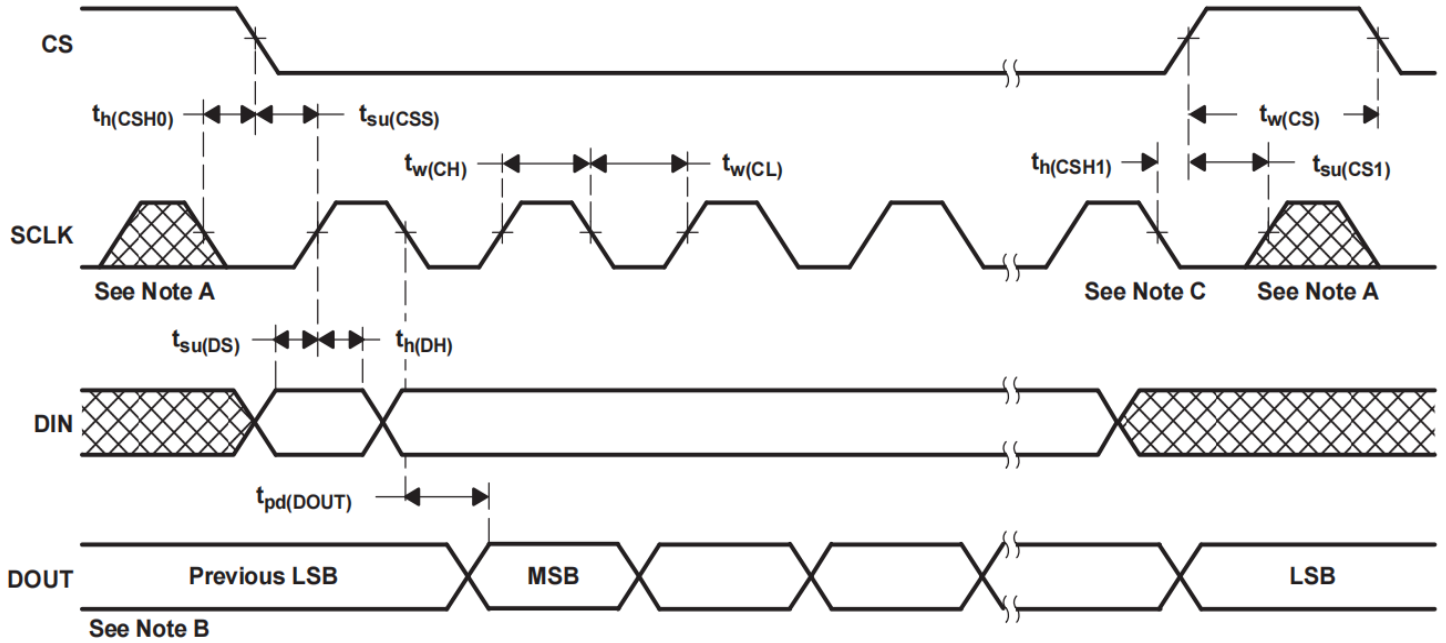
(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions

		Min	Nom	Max	Unit
Supply voltage,VoD		4.5	5	5.5	V
High-level digital input voltage,VH		2.4			V
Low-level digital input voltage,VL				0.8	V
Reference voltage,Vref to REFIN terminal		2	2.048	VDD-2	V
Load resistance,RL		2			k
Operating free-air temperature,TA	TLC5615C	0		70	
	TLC5615I	40		85	



Parameter Measurement Information



- NOTES: A. The input clock, applied at the SCLK terminal, should be inhibited low when CS is high to minimize clock feedthrough.
 B. Data input from preceding conversion cycle.
 C. Sixteenth SCLK falling edge

Figure 1. Timing Diagram

Digital Input Timing Requirements (See Figure 1)

Parameter	Min	Nom	Max	Unit
$t_{su}(DS)$	45			ns
$t_n(DH)$	0			ns
$t_{su}(CSS)$	1			ns
$t_{su}(CS1)$	50			ns
$t_n(CSH0)$	1			ns
$t_n(CSH_i)$	0			ns
$t_w(CS)$	20			ns
$t_w(CL)$	25			ns
$t_w(CH)$	25			ns



Electrical Characteristics

over recommended operating free-air temperature range, $V_{DD} = 5V \pm 5\%$, $V_{ref} = 2.048V$ (unless otherwise noted)

Static DAC specifications					
Parameter	Test conditions	Min	Typ	Max	Unit
Resolution		10			bits
Integral nonlinearity, end point adjusted (INL)	$V_{ref} = 2.048V$, See(1)			± 1	LSB
Differential nonlinearity (DNL)	$V_{ref} = 2.048V$, See(2)		± 0.1	± 0.5	LSB
Ezs Zero-scale error (offset error at zero scale)	$V_{ref} = 2.048V$, See(3)			± 3	LSB
Zero-scale-error temperature coefficient	$V_{ref} = 2.048V$, See(4)		3		ppm/°C
EG Gain error	$V_{ref} = 2.048V$, See(5)			± 3	LSB
Gain-error temperature coefficient	$V_{ref} = 2.048V$, See(6)	80	1		ppm/°C
PSRR Power-supply rejection ratio	Zero scale	See(7)(8)	80		dB
	Gain				
Analog full scale output	$R_L = 100k\Omega$	$2V_{ref}(1023/1024)$			V

(1) The relative accuracy or integral nonlinearity (INL), sometimes referred to as linearity error, is the maximum deviation of the output from the line between zero and full scale excluding the effects of zero code and full-scale errors (see text). Tested from code 3 to code 1024.

(2) The differential nonlinearity (DNL), sometimes referred to as differential error, is the difference between the measured and ideal 1LSB amplitude change of any two adjacent codes. Monotonic means the output voltage changes in the same direction (or remains constant) as a change in the digital input code. Tested from code 3 to code 1024.

(3) Zero-scale error is the deviation from zero-voltage output when the digital input code is zero (see text).

(4) Zero-scale-error temperature coefficient is given by: $EzsTC = [Ezs(T_{max}) - Ezs(T_{min})] / V_{ref} \times 10^6 / (T_{max} - T_{min})$.

(5) Gain error is the deviation from the ideal output ($V_{ref} - 1LSB$) with an output load of $10k\Omega$ excluding the effects of the zero-scale error.

(6) Gain temperature coefficient is given by: $EgTC = [Eg(T_{max}) - Eg(T_{min})] / V_{ref} \times 10^6 / (T_{max} - T_{min})$.

(7) Zero-scale-error rejection ratio (Ezs-RR) is measured by varying the V_{DD} from 4.5V to 5.5V dc and measuring the proportion of this signal imposed on the zero-code output voltage.

(8) Gain-error rejection ratio (Eg-RR) is measured by varying the V_{DD} from 4.5V to 5.5V dc and measuring the proportion of this signal imposed on the full-scale output voltage after subtracting the zero-scale change.



Voltage Output (Out)

Parameter	Test conditions	Min	Typ	Max	Unit
Digital Output (DOUT)					
VoH Output voltage,high-level	Io=-2mA	VDD-1			V
VoL Output voltage,low-level	Io=2mA			0.4	V
Power Supply					
VDD Supply voltage		4.5	5	5.5	V
DD Power supply current	VDD=5.5V,No load, All inputs =0V or VDD	Vref=0	150	250	μA
	VDD=5.5V,No load, Allinputs =0V or VDD	Vref=2.048V	230	350	μA
Analog output dynamic performance					
Signal-to-noise +distortion,S/(N+D)	Vref=1Vpp at 1kHz+2.048Vdc, code=111111111(1)		60		dB
Vo Voltage output range	RL=10kΩ	0		VDD-0.4	V
Output load regulation accuracy	Vo(oUT)=2V, RL=2kΩ			0.5	LSB
Iosc Output short circuit current	OUT to VoD or AGND		20		mA
VoLow) Output voltage,low-level	Io(oUT)≤5mA			0.25	V
VoH(high) Output voltage,high-level	Io(oUT)≤-5mA	4.75			V
Reference Input					
VI Input voltage		0		VDD-2	V
ri Input resistance		10			MQ
Ci Input capacitance			5		pF
Digital Input (DIN, SCLK, CS)					
VIH High-level digital input voltage		2.4			V
VIL Low-level digital input voltage				0.8	V
IH High-level digital input current	V ₁ =VDD			± 1	μA
IL Low-level digital input current	V ₁ =0			± 1	μA
C; Input capacitance			8		pF

(1) The limiting frequency value at 1Vppis determined by the output-amplifier slew rate.



Output Switching Characteristics

Parameter	Test Conditions	Min	Nom	Max	Unit
tpd(DOUT) Propagation delay time,DOUT	CL=50pF			50	ns

Operating Characteristics

over recommended operating free-air temperature range, $V_{DD} = 5V \pm 5\%$, $V_{ref} = 2.048V$ (unless otherwise noted)

Parameter	Test Conditions		Min	Typ	Max	Unit
Analog output dynamic performance						
SR Output slew rate	CL=100pF, TA=+25°C	RL=10kΩ,	0.3	0.5		V/μs
ts Output settling time	To 0.5LSB, RL=10kΩ,	CL=100pF,(1)		12.5		μs
Glitch energy	DIN =All Os to all 1s			5		nV-s
Reference Input						
Reference feedthrough	REFIN=1Vpp at 1kHz+2.048Vdc(2)			-80		dB
Reference input bandwidth(f-3dB)	REFIN =0.2Vpp+2.048Vdc			30		kHz

(1) Settling time is the time for the output signal to remain within $\pm 0.5LSB$ of the final measured value for a digital input code change of 000 hex to 3FF hex or 3FF hex to 000 hex.

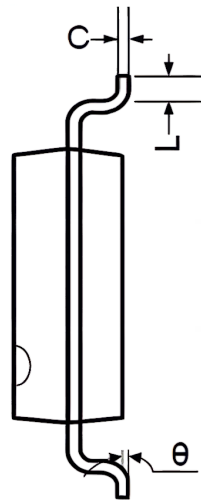
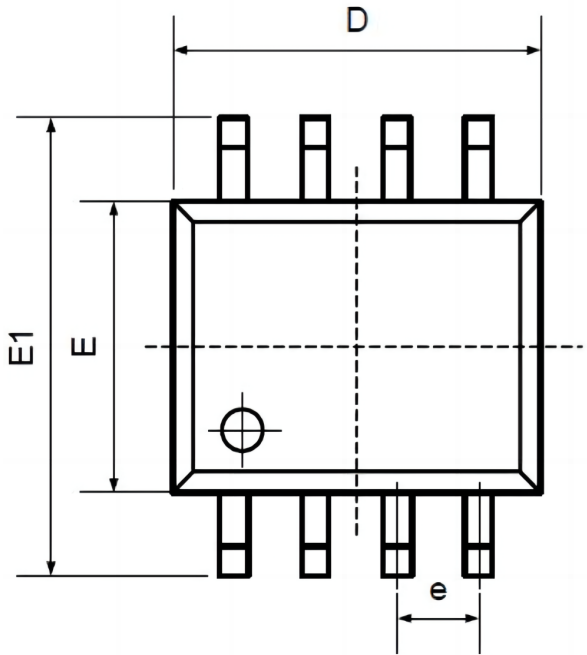
(2) Reference feedthrough is measured at the DAC output with an input code = 000 hex and $aV_{refinput} = 2.048Vdc + 1Vpp$ at 1kHz.

Order information

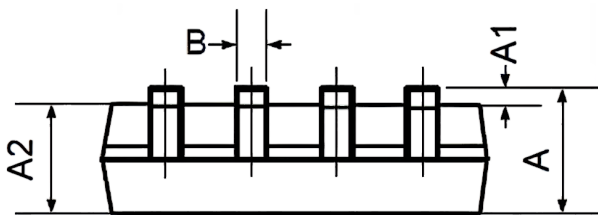
Order Number	Package	Package Quantity	Marking On The park	Temperature
TLC5615CDR-TUDI	SOP8	Tape,Reel,2500	5615C	0°C to 70°C
TLC5615CP-TUDI	DIP8	Tube,50,A box of 2000	TLC5615CP	
TLC5615IDR-TUDI	SOP8	Tape,Reel,2500	5615I	-40°C to 85°C
TLC5615IP-TUDI	DIP8	Tube,50,A box of 2000	TLC5615IP	



Package SOP8

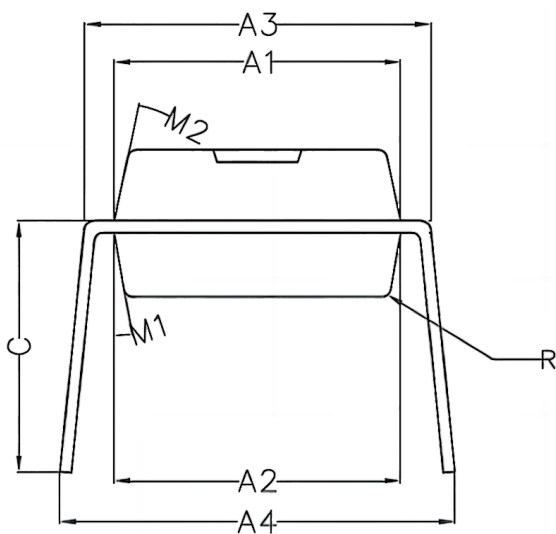
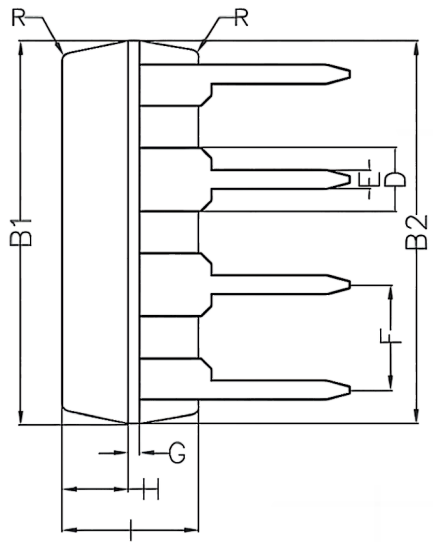
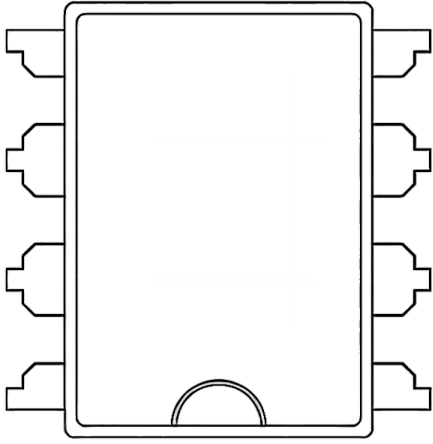


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP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





Package DIP8



Symbol	Min	Non	Max
A1	6.28	6.33	6.38
A2	6.33	6.38	6.43
A3	7.52	7.62	7.72
A4	7.80	8.40	9.00
B1	9.15	9.20	9.25
B2	9.20	9.25	9.30
C		5.57	
D		1.52	
E	0.43	0.45	0.47
F		2.54	
G		0.25	
H	1.54	1.59	1.64
I	3.22	3.27	3.32
R		0.20	
M1	9°	10°	11°
M2	11°	12°	13°



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.