



AiP1928

3-Line Serial Interface, Common Cathode, 10 Seg ×7 Grid or 13 Seg ×4 Grid LED Driver and Controller with Ghost Elimination and 10 ×2 Keyboard input Ports

Product Specification

Specification Revision History:

Version	Date	Description
2018-05-A1	2018-05	New
2025-08-B1	2025-08	Update the template; modify ambient temperature and soldering temperature; modify ordering information and package information



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1、General Description

AiP1928 is a 3-line serial interface, common cathode, 10 seg×7 grid or 13 seg×4 grid LED driver and controller with ghost elimination and 10×2 keyboard input ports. It features a 3-line serial communication interface and RC oscillator, with 8-level of adjustable brightness. It is widely applied in all kinds of LED panel occasions.

Features:

- Built-in display RAM
- Display mode software adjustable
- Initialization and clear on power-on of RAM
- 10×2 scanning key matrix
- Display brightness software adjustable
- 3-line serial interface (CLK, STB, DIO)
- Built-in RC oscillation
- Built-in ghost elimination function
- Packaging form: SOP28/SSOP28(0.635mm)

Application Area:

LED display panel occasions, such as microwave oven, induction cooker, water heater and other household appliances.

**Ordering Information:****Tube packing specifications:**

Part number	Packaging form	Marking code	Tube quantity	Boxed tube quantity	Boxed quantity	Notes
AiP1928SA28.TB	SOP28	AiP1928	25 PCS/tube	80 tube/box	2000 PCS/box	Dimensions of plastic enclosure: 17.9mm×7.5mm Pin spacing: 1.27mm
AiP1928VB28.TB	SSOP28	AiP1928	50 PCS/tube	200 tube/box	10000 PCS/box	Dimensions of plastic enclosure: 9.9mm×3.9mm Pin spacing: 0.635mm

Reel packing specifications:

Part number	Packaging form	Marking code	Reel quantity	Boxed reel quantity	Notes
AiP1928SA28.TR	SOP28	AiP1928	1250PCS/reel	1250PCS/box	Dimensions of plastic enclosure: 17.9mm×7.5mm Pin spacing: 1.27mm
AiP1928VB28.TR	SSOP28	AiP1928	4000PCS/reel	8000PCS/box	Dimensions of plastic enclosure: 9.9mm×3.9mm Pin spacing: 0.635mm

Note: If the physical information is inconsistent with the ordering information, please refer to the actual product.



2、Pin Description and Pin Description

2.1、Pin Configurations

1	NC	GND	28
2	DIO	GRID1	27
3	CLK	GRID2	26
4	STB	GND	25
5	K1	GRID3	24
6	K2	GRID4	23
7	VDD	GND	22
8	SEG1/KS1	VDD	21
9	SEG2/KS2	SEG14/GRID5	20
10	SEG3/KS3	SEG13/GRID6	19
11	SEG4/KS4	SEG12/GRID7	18
12	SEG5/KS5	SEG10/KS10	17
13	SEG6/KS6	SEG9/KS9	16
14	SEG7/KS7	SEG8/KS8	15

2.2、Pin Description

Pin No.	Pin Name	I/O	Description
1	NC	-	Floating
2	DIO	IO	Data port, N-tube open-drain output, built-in pull-down resistance
3	CLK	I	Clock port
4	STB	I	Clip select port
5	K1	I	Key input port, built-in pull-down resistance
6	K2	I	Key input port, built-in pull-down resistance
7	VDD	-	Power supply
8	SEG1/KS1	O	Segment output/key scanning output, P-tube open-drain output
9	SEG2/KS2	O	Segment output/key scanning output, P-tube open-drain output
10	SEG3/KS3	O	Segment output/key scanning output, P-tube open-drain output
11	SEG4/KS4	O	Segment output/key scanning output, P-tube open-drain output
12	SEG5/KS5	O	Segment output/key scanning output, P-tube open-drain output
13	SEG6/KS6	O	Segment output/key scanning output, P-tube open-drain output
14	SEG7/KS7	O	Segment output/key scanning output, P-tube open-drain output
15	SEG8/KS8	O	Segment output/key scanning output, P-tube open-drain output
16	SEG9/KS9	O	Segment output/key scanning output, P-tube open-drain output
17	SEG10/KS10	O	Segment output/key scanning output, P-tube



			open-drain output
18	SEG12/GRID7	O	Segment/Grid multiplexed output, P/N-tube open-drain output
19	SEG13/GRID6	O	Segment/Grid multiplexed output, P/N-tube open-drain output
20	SEG14/GRID5	O	Segment/Grid multiplexed output, P/N-tube open-drain output
21	VDD	-	Power supply
22	GND	-	Ground
23	GRID4	O	Grid output, N-tube open-drain output
24	GRID3	O	Grid output, N-tube open-drain output
25	GND	-	Ground
26	GRID2	O	Grid output, N-tube open-drain output
27	GRID1	O	Grid output, N-tube open-drain output
28	GND	-	Ground

3、Electrical Parameter

3.1、Absolute Maximum Ratings

($T_{amb}=25^{\circ}\text{C}$, GND=0V, unless otherwise specified)

Parameter	Symbol	Conditions	Value	Unit
Power Supply Voltage	VDD	-	-0.5 to +7.0	V
Logic Input Voltage	VIN	-	-0.5 to VDD+0.5	V
Output High-Level Current (SEG)	I _{O1}	-	-50	mA
Output Low-Level Current (GRID)	I _{O2}	-	+150	mA
Ambient Temperature	T _{amb}	-	-40 to +105	°C
Storage Temperature	T _{stg}	-	-65 to +150	°C
Soldering Temperature	T _L	10s	260	°C

3.2、Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Logic Power Supply Voltage	VDD	3	5	5.5	V
High-Level Input Voltage	V _{IH}	0.7VDD	-	VDD	V
Low-Level Input Voltage	V _{IL}	0	-	0.2VDD	V



3.3、Electrical Characteristics

3.3.1、DC Characteristics

(VDD=5V, GND=0V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Output High-Level Current	I _{OH1}	V _O =VDD-2V, SEGn	-20	-25	-40	mA
	I _{OH2}	V _O =VDD-3V, SEGn	-20	-30	-50	mA
Output Low-Level Current	I _{OL1}	V _O = 0.3V, GRIDn	80	100	-	mA
	I _{DO}	V _O =0.4V, DIO	4	8	-	mA
High-Level Output Current Tolerance	I _{TOLSG}	V _O =VDD-3V, SEGn	-	-	5	%
Input High-Level Voltage	V _{IH}	CLK, DIO, STB	0.7VDD	-	-	V
Input Low-Level Voltage	V _{IL}	CLK, DIO, STB	-	-	0.2VDD	V
Hysteresis Voltage	V _H	CLK, DIO, STB	-	0.35	-	V
Input Leakage Current	I _I	VIN=VDD, STB, CLK, DIO	-	-	±1	uA
		VIN=GND, STB, CLK	-	-	±1	uA
		VIN=GND, DIO	300	500	700	uA
Quiescent Current	I _{DD}	No load, VIN=VDD	140	160	180	uA
Input Pull-down Resistance	R _L	K0~K3	-	10	-	kΩ
Input Pull-up Resistance	R _{IP}	DIO	-	10	-	kΩ

3.3.2、AC Characteristics 1

(VDD=4.5V to 5.5V, GND=0V, unless otherwise specified)

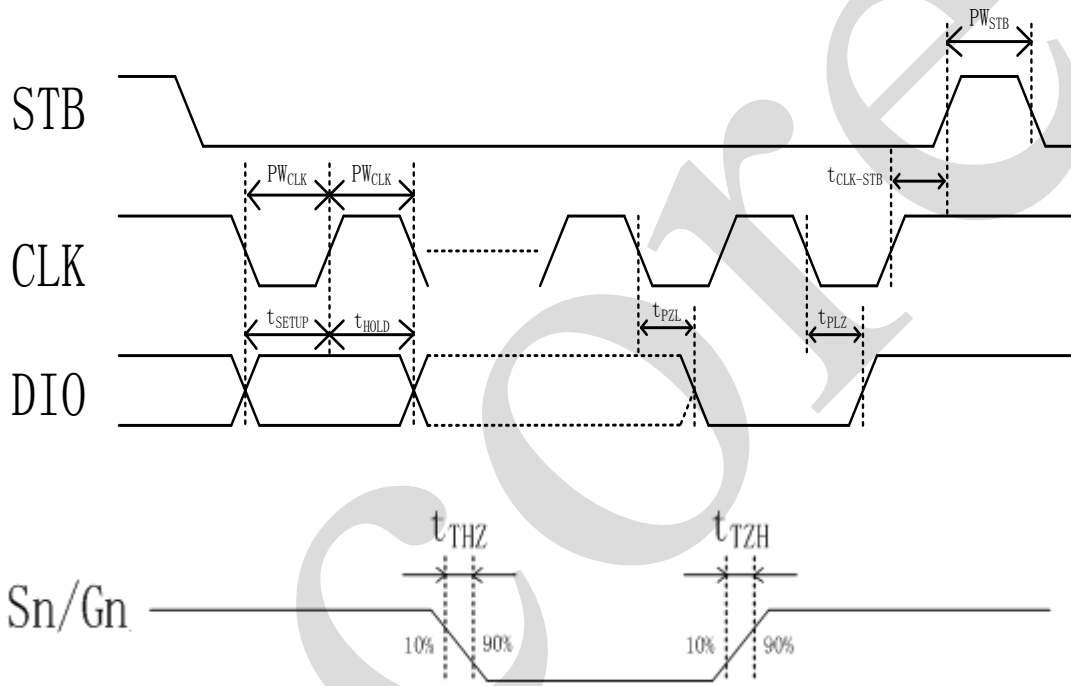
Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Oscillation frequency	f _{OSC}	-		-	400	-	kHz
Transmission Delay Time	t _{PLZ}	CLK→DIO, C _L =15pF, R _L =10kΩ		-	-	300	ns
	t _{PZL}			-	-	100	ns
Rise Time	t _{TZH1}	C _L =300pF	SEGn	-	-	2	us
	t _{TZH}		GRIDn	-	-	0.5	us
Fall Time	t _{THZ}	C _L =300pF, SEGn, GRIDn		-	-	120	us
Maximum Clock Frequency	f _{max}	Duty Cycle 50%		1	-	-	MHz



3.3.3、AC Characteristics 2

(VDD=4.5V to 5.5V, GND=0V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Clock Pulse Width	PW_{CLK}	-	400	-	-	ns
Gate Width	PW_{STB}	-	1	-	-	us
Data Setup Time	t_{SETUP}	-	100	-	-	ns
Data Hold Time	t_{HOLD}	-	100	-	-	ns
CLK→STB Time	$t_{CLK-STB}$	CLK↑→STB↑	1	-	-	us
Waiting Time	t_{WAIT}	CLK↑→CLK↓	1	-	-	us





4、Function Description

4.1、Display Register Address

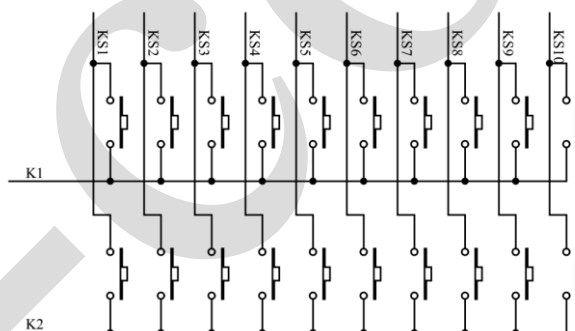
The register stores the data transmitted from the external device to AiP1928 via a serial interface, and the address is assigned as follows:

X	X	SEG14	SEG13	SEG12	X	SEG10	SEG9	SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1		
xxHU (High Four)				xxHL(Low Four)				xxHU (High Four)				xxHL(Low Four)					
B7	B6	B5	B4	B3	B2	B1	B0	B7	B6	B5	B4	B3	B2	B1	B0		
01HU				01HL				00HU				00HL				GRID1	
03HU				03HL				02HU				02HL				GRID2	
05HU				05HL				04HU				04HL				GRID3	
07HU				07HL				06HU				06HL				GRID4	
09HU				09HL				08HU				08HL				GRID5	
0BHU				0BHL				0AHU				0AHL				GRID6	
0DHU				0DHL				0CHU				0CHL				GRID7	

Note: AiP1928 features a built-in function that initializes and clears the RAM upon power-on, meaning the display RAM defaults to 0 after power-on.

4.2、Key Scan and Key Scan Data Register

The key scan matrix is 10×2, as shown in the figure below:



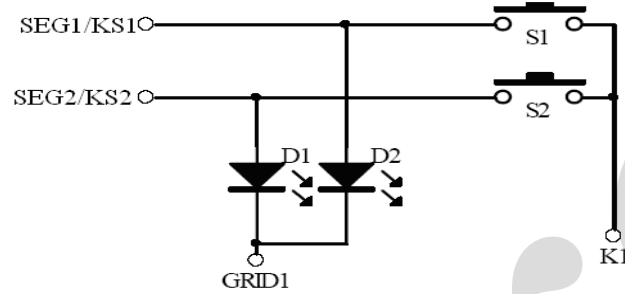
The key scan data storage data is as follows. After running the read key command, read the key data BYTE1-BYTE5 bytes. The read data is output from the low bit, and B6 and B7 bits are invalid bits and fixedly output 0. When the key corresponding to the K and KS pins of the chip is pressed, the Bit in the corresponding byte is 1.

B0	B1	B2	B3	B4	B5	B6	B7
K1	K2	X	K1	K2	X	0	0
KS1		KS2		0		0	BYTE1
KS3		KS4		0		0	BYTE2
KS5		KS6		0		0	BYTE3
KS7		KS8		0		0	BYTE4
KS9		KS10		0		0	BYTE5

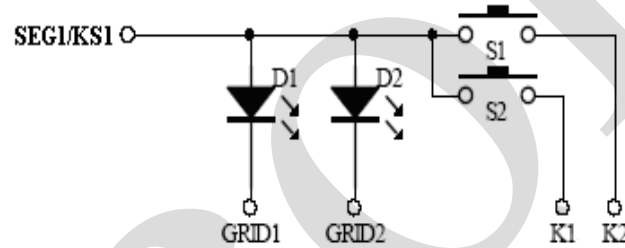


4.2.1、Combination Key

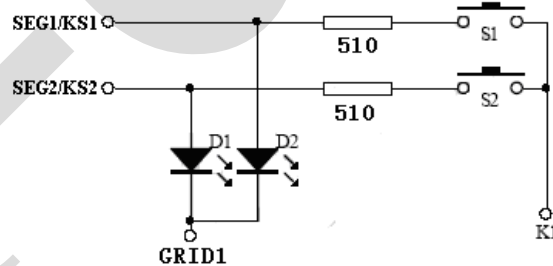
Key scanning is automatically completed by AiP1928, which is not controlled by the user, and the user only needs to read the key value according to the timing. It takes 2 display cycles to complete a key scan, and SEG1/KS1-SEG10/KS10 are multiplex of display and key scan. As shown in the following figure, if D1 is off and D2 is on, set SEG1 to 1 and SEG2 to 0. If S1 and S2 are pressed at the same time, SEG1 and SEG2 are short-circuited. In this case, both D1 and D2 are lit, resulting in abnormal display. When you need to use a combination of keys, there are a few things to pay attention to:



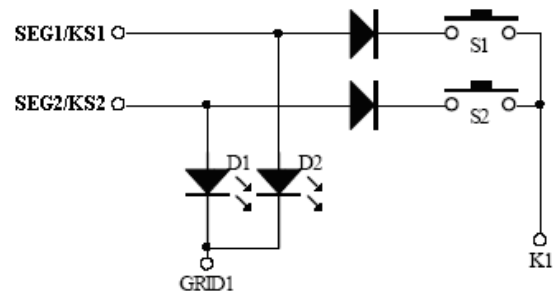
1. On the hardware, the keys that need to be pressed at the same time can be set on different K-lines, as shown in the figure below.



2. Install the resistance in series on SEG1-SEGN. The resistance value of the resistance should be selected at 510 ohms. If the value is too large, it will cause the key to lose efficiency; if the value is too small, it may fail to solve the problem of display interference, as shown in the figure below:



3. Install the diodes in series on SEG1-SEGN, as shown in the figure below.





4.3、Instruction Introduction

Each time the STB port changes from high to low, the first byte sent into the circuit from the DIO port is used as an introduction input, and the second byte is used as a data input. The higher two digits in a command are used to distinguish between different commands.

B7	B6	Command
0	0	Display mode setting
0	1	Data command setting
1	0	Display control command setting
1	1	Address command setting

If STB is set to high during command or data transmission, serial communication is initialized and the command or data being transmitted is invalid (the previously transmitted instruction or data remains valid).

4.3.1、Display Mode Setting

This command is used to set the number of driven segments and grids. When the command is executed, the display is forcibly turned off. To restore the display, the display on/off command “ON” must be executed. However, this does not occur if the same mode is being set.

MSB				LSB				Display Mode
B7	B6	B5	B4	B3	B2	B1	B0	
0	0	Irrelevant term, write 0				0	0	13 seg×4 grid
0	0					0	1	12 seg×5 grid
0	0					1	0	11 seg×6 grid
0	0					1	1	10 seg×7 grid

Note: The default display mode of AiP1928 is 10 seg×7 grid.

4.3.1、Data Setting

This command is used to set data reading and writing. B1 and B0 cannot be set to 01 and 11.

MSB				LSB				Function	Description
B7	B6	B5	B4	B3	B2	B1	B0		
0	1	Irrelevant term, write 0				-	-	Read-write mode setting	Write data to the display register
0	1					-	-		Read the key value
0	1					-	0	Address mode setting	Address auto-adding mode
0	1					-	1		Fixed address mode
0	1					0	-	Test mode setting	Normal mode
0	1					1	-		Test mode (internal use)



4.3.2、Address setting

This command is used to set the address of the display register. If the address is set higher than 0DH, the data is ignored until the effective address is set. During powering on, the default address is 00H.

MSB

LSB

B7	B6	B5	B4	B3	B2	B1	B0	Display Address
1	1	Irrelevant term, write 0		0	0	0	0	00H
1	1			0	0	0	1	01H
1	1			0	0	1	0	02H
1	1			0	0	1	1	03H
1	1			0	1	0	0	04H
1	1			0	1	0	1	05H
1	1			0	1	1	0	06H
1	1			0	1	1	1	07H
1	1			1	0	0	0	08H
1	1			1	0	0	1	09H
1	1			1	0	1	0	0AH
1	1			1	0	1	1	0BH
1	1			1	1	0	0	0CH
1	1			1	1	0	1	0DH

4.3.3、Display Control

This command is used to turn the display on/off and adjust the display brightness. The circuit offers eight-level brightness adjustment.

MSB

LSB

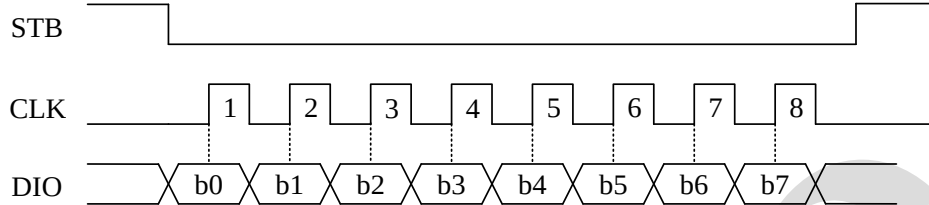
B7	B6	B5	B4	B3	B2	B1	B0	Function	Description
1	0	Irrelevant term, write 0		-	0	0	0	Display brightness setting	Set the pulse width to 1/16
1	0			-	0	0	1		Set the pulse width to 2/16
1	0			-	0	1	0		Set the pulse width to 4/16
1	0			-	0	1	1		Set the pulse width to 10/16
1	0			-	1	0	0		Set the pulse width to 11/16
1	0			-	1	0	1		Set the pulse width to 12/16
1	0			-	1	1	0		Set the pulse width to 13/16
1	0			-	1	1	1		Set the pulse width to 14/16
1	0			0	-	-	-	Display switch setting	Display off
1	0			1	-	-	-		Display on



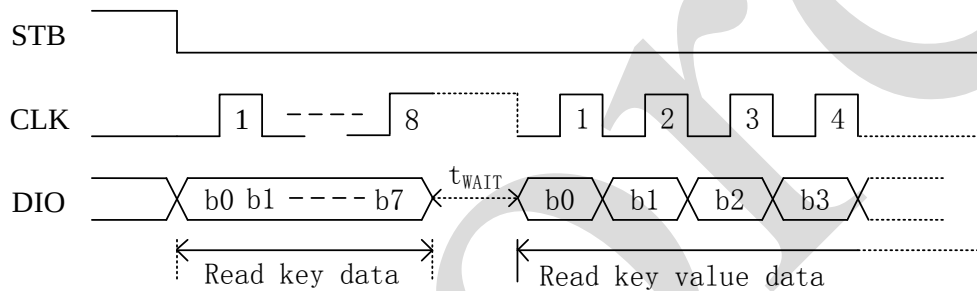
4.4、Serial Data Transmission Format

Both reading and receiving 1 bit operate on the rising edge of the clock.

4.4.1、Write Data



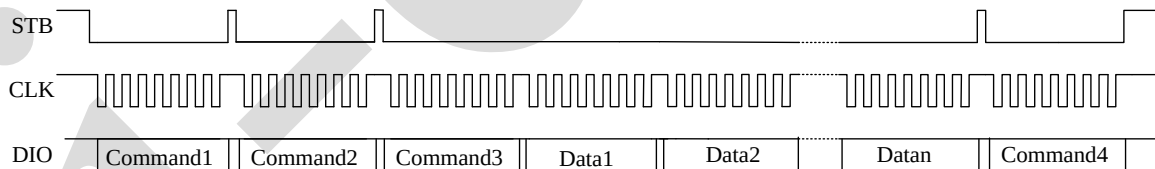
4.4.2、Read Data



Note: When reading data, a waiting period t_{WAIT} (min. 1us) is required between setting the instruction at the beginning of the 8th rising edge of the serial clock CLK and reading the data at the falling edge of CLK.

4.5、Transmission of Serial Data in Application

4.5.1、Address Increment Mode Communication Timing



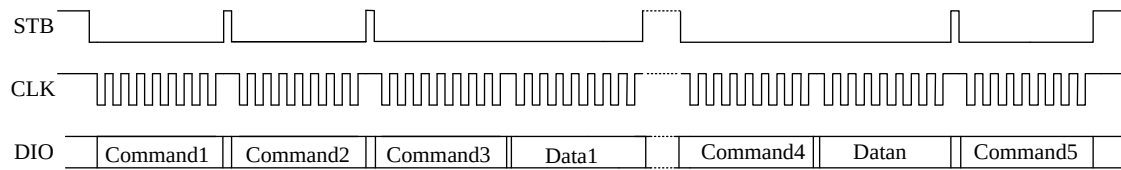
Command1: Set display mode

Command2: Set data command

Command3: Set display address

Data1~Datan: Transmit display data

Command4: Display control command

**4.5.2、Fixed Address Mode Communication Timing**

Command1: Set display mode

Command2: Set data command

Command3: Set display address 1

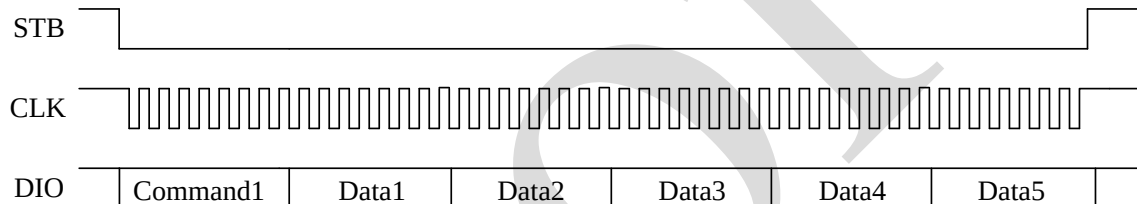
Data1: Display data written into Command3 address

⋮

Command4: Set display address N

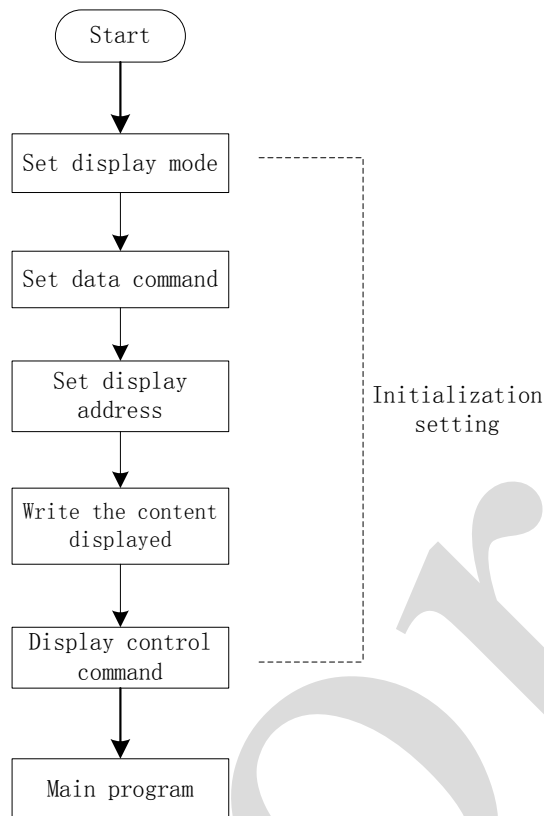
Datan: Display data written into Command4 address

Command5: Display control command

4.5.3、Read Key Value Timing

Command1: Set read key command

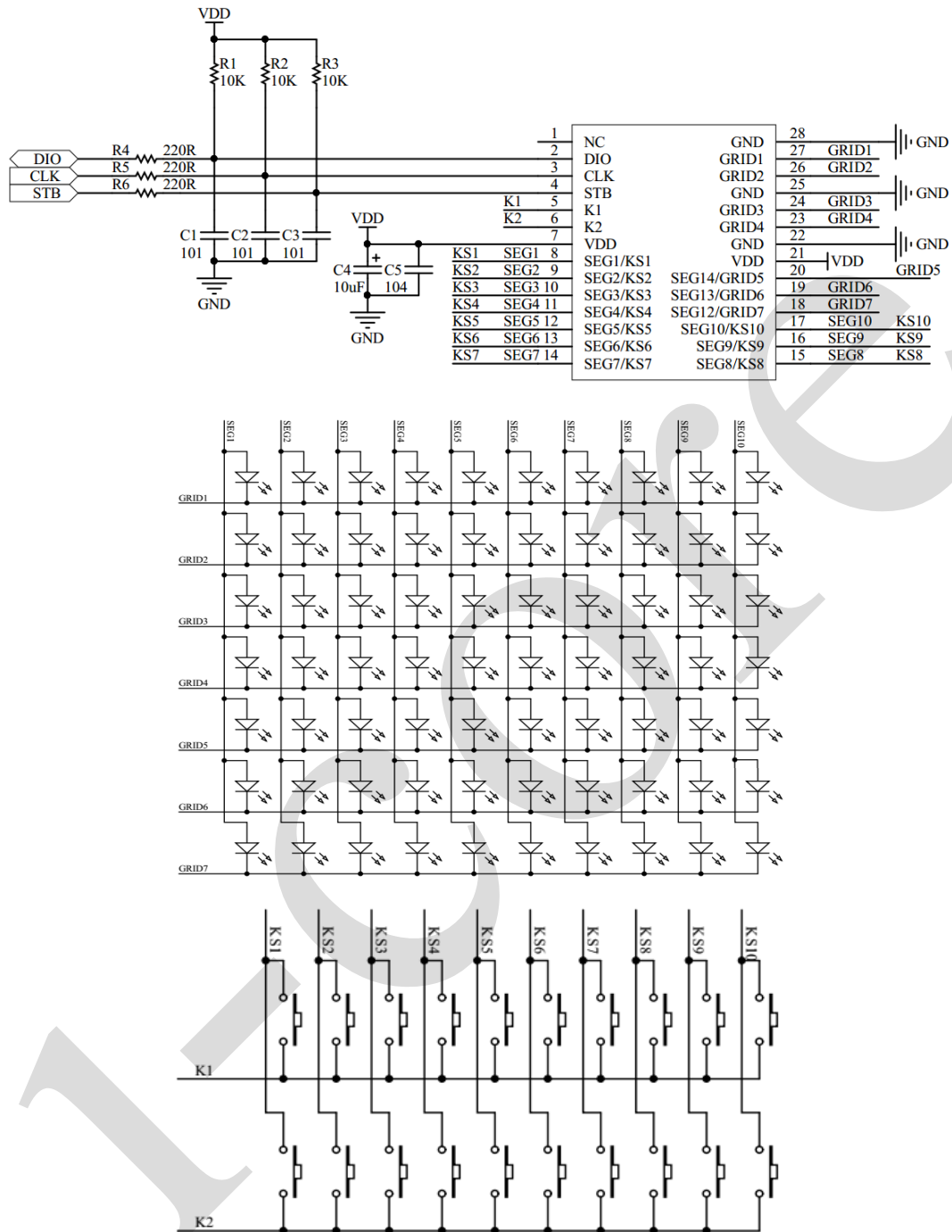
Data1~5: Key value data that is read

**4.6、Initialization Flowchart****Note:**

1. The display mode setting is used to select the number of segments and grids for driving the display screen. This should be configured based on the user's actual hardware connections and is generally set only during the initialization phase. The default display mode of AiP1928 is 10 seg×7 grid.
2. The data instruction is used to choose whether to write the display data to the RAM area (which is divided into fixed address and address auto-adding) or to read the key value.
3. AiP1928 features a built-in power-on RAM clear function. If display data is not written and the display is directly turned on, there will be no output.
4. AiP1928 has a blanking function to prevent dim illumination issues in LEDs.



5、Typical Application Circuit



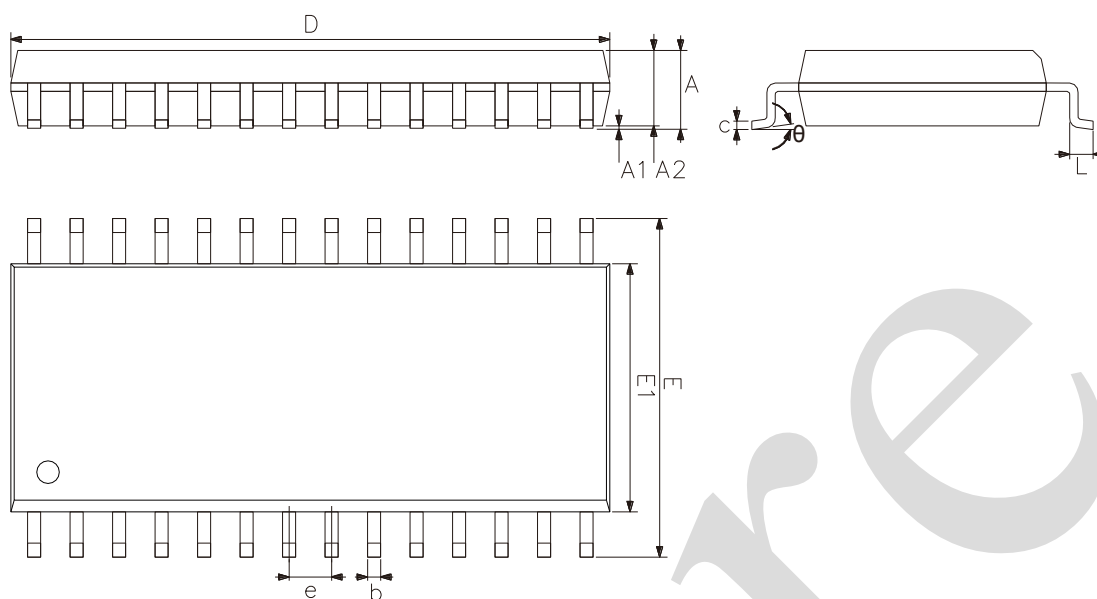
Note:

1. The filtering capacitor between VDD and GND should be close to AiP1928 to enhance the filtering effect.
2. In order to improve the anti-interference ability of the circuit, it is recommended to connect the communication port according to the figure above, and the specific parameter values can be adjusted according to the actual needs.



6、Package Information

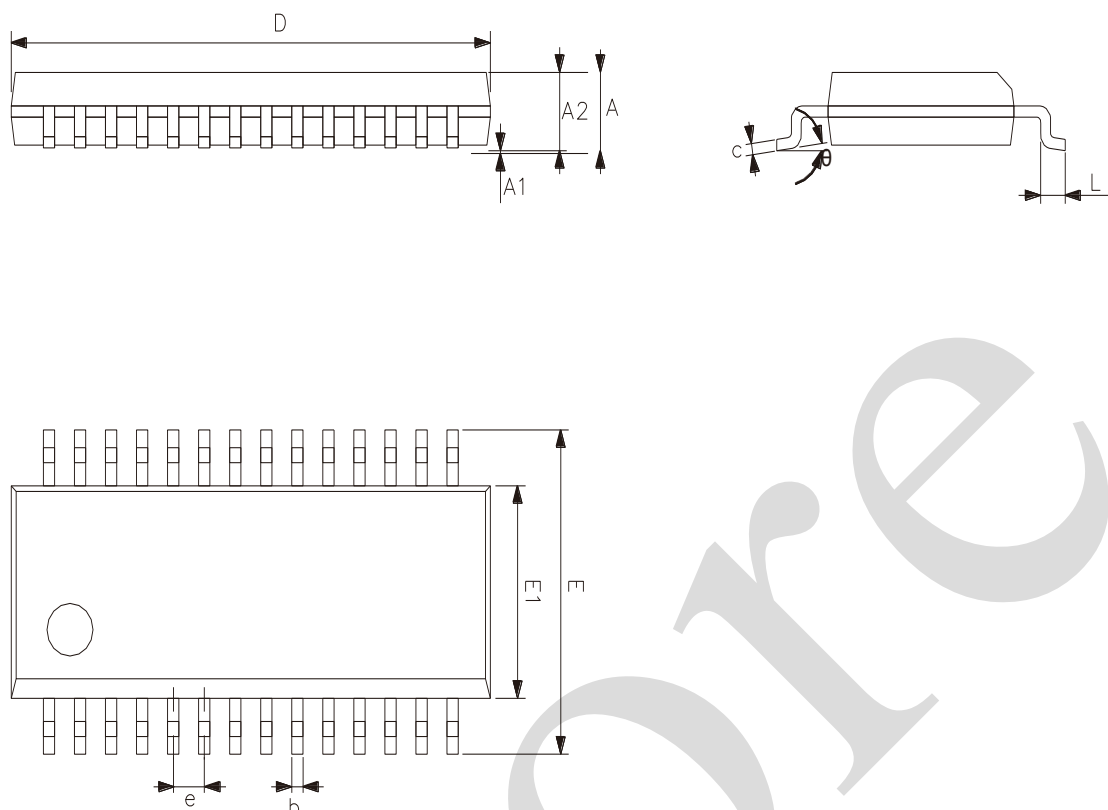
6.1、SOP28



2023/12/A	Dimensions In Millimeters	
Symbol	Min.	Max.
A	2.15	2.75
A1	0.03	0.30
A2	2.05	2.44
b	0.35	0.51
c	0.20	0.36
D	17.70	18.30
E	10.00	10.65
E1	7.30	7.70
e	1.27	
L	0.40	1.27
θ	0°	8°



6.2、SSOP28 (0.635mm)



2023/12/A	Dimensions In Millimeters	
Symbol	Min	Max
A	—	1.75
A1	0.02	0.25
A2	1.30	1.60
b	0.23	0.31
c	0.19	0.25
D	9.75	10.00
E	5.80	6.45
E1	3.75	4.00
e	0.635	
L	0.35	0.80
θ	0°	8°



7、Statements And Notes

7.1、The name and content of Hazardous substances or Elements in the product

Part name	Hazardous substances or Elements									
	Lead and lead compounds	Mercury and mercury compounds	Cadmium and cadmium compounds	Hexavalent chromium compounds	Polybrominated biphenyls	Polybrominated biphenyl ethers	Dibutyl phthalate	Butylbenzyl phthalate	Di-2-ethylhexyl phthalate	Diisobutyl phthalate
Lead frame	○	○	○	○	○	○	○	○	○	○
Plastic resin	○	○	○	○	○	○	○	○	○	○
Chip	○	○	○	○	○	○	○	○	○	○
The lead	○	○	○	○	○	○	○	○	○	○
Plastic sheet installed	○	○	○	○	○	○	○	○	○	○
explanation	○: Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard. ×: Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements.									

7.2、Notes

We recommend you to read this chapter carefully before using this product.

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