



AiP33504

4-channel constant current LED column driver circuit

Product Specification

Specification Revision History:

Version	Date	Description
2022-11-A0	2022-11	New
2024-05-A1	2024-05	Revise the content



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1、General Description

AiP33504 is a 4-channel constant current LED column driving circuit that provides 4 anode driving ports that can output constant current. Each channel can independently adjust the output duty cycle through software, thereby controlling the display brightness of the LED driven by each channel separately.

Its main features are as follows:

- 4-channel constant current anode drive terminal
- Software adjustable output current, maximum 30mA
- Single channel adjustment, software adjustable output duty cycle of each channel
- Two-wire serial interface
- Built-in power-on reset circuit
- Built-in low voltage reset circuit
- Built-in blanking circuit
- Supply voltage: 3.0V to 5.5V
- Package: SOP8/MSOP8/DFN8



Ordering Information:

Tube packing specifications:

Part number	Packaging form	Marking code	Tube quantity	Boxed tube quantity	Boxed quantity	Notes
AiP33504SA8.TB	SOP8	AiP33504	100 PCS/tube	100 tube/box	10000 PCS/box	Size of plastic enclosure: 4.9mm×3.9mm Pin spacing: 1.27mm
AiP33504MA8.TB	MSOP8	33504	100 PCS/tube	100 tube/box	10000 PCS/box	Size of plastic enclosure: 3.0mm×3.0mm Pin spacing: 0.65mm

Reel packing specifications:

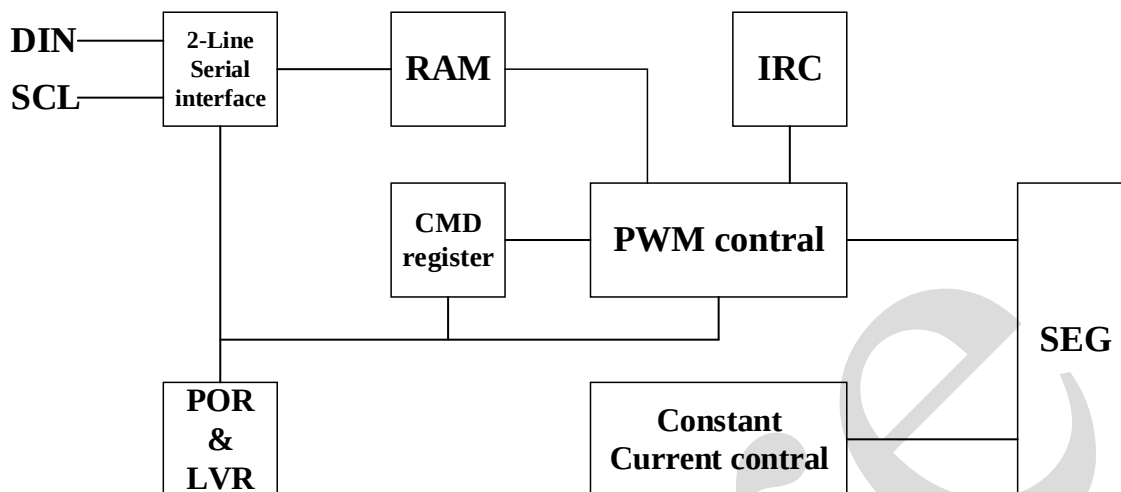
Part number	Packaging form	Marking code	Reel quantity	Boxed reel quantity	Notes
AiP33504SA8.TR	SOP8	AiP33504	4000 PCS/reel	8000 PCS/box	Size of plastic enclosure: 4.9mm×3.9mm Pin spacing: 1.27mm
AiP33504MA8.TR	MSOP8	33504	5000 PCS/reel	10000 PCS/box	Size of plastic enclosure: 3.0mm×3.0mm Pin spacing: 0.65mm
AiP33504XB8.TR	DFN8	33504	3000 PCS/reel	30000 PCS/box	Size of plastic enclosure: 2.0mm×2.0mm Pin spacing: 0.50mm

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

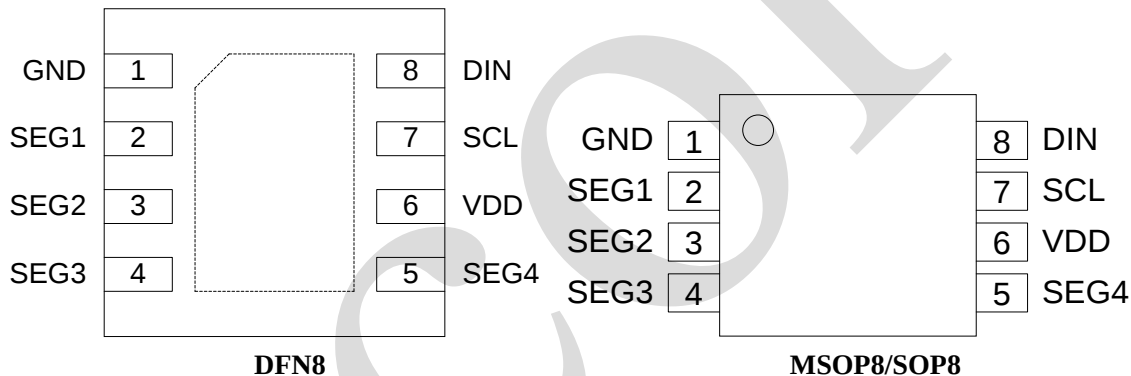


2、Block Diagram And Pin Explanation

2.1、Block Diagram



2.2、Pin Configurations



2.3、Pin Description

Pin No.	Pin Name	Description
1	GND	Ground
2	SEG1	LED constant current driver, SEG output
3	SEG2	LED constant current driver, SEG output
4	SEG3	LED constant current driver, SEG output
5	SEG4	LED constant current driver, SEG output
6	VDD	Power Supply
7	SCL	serial interface clock
8	DIN	serial interface data



3、Electrical Characteristics

3.1、Limiting Values

($T_{amb}=25^{\circ}\text{C}$, unless there are specific rules)

Parameter	Symbol	Conditions	Ratings	Unit
Power Supply Voltage	VDD	-	-0.5 to +7.0	V
Power supply current	I_{DD}	-	20	mA
Power Dissipation	P_D	-	450	mW
Storage Temperature	T_{stg}	-	-65 to +150	$^{\circ}\text{C}$
Lead Temperature	T_L	10s	260	$^{\circ}\text{C}$

3.2、Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Logic Power Supply Voltage	VDD	3.0	5	5.5	V
High Level Input Voltage	V_{IH}	$0.7 \times VDD$	—	VDD	V
Low Level Input Voltage	V_{IL}	0	—	$0.3 \times VDD$	V
Ambient Temperature	T_{amb}	-40	-	+85	$^{\circ}\text{C}$

3.3、Electrical Characteristics

3.3.1、DC Characteristics

($T_{amb}=25^{\circ}\text{C}$, VDD=5V, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Logic Power Supply Voltage	VDD	—	3	5	5.5	V
Power-On/Power-Down Reset Voltage	V_{PR}	—	—	2	—	V
High Level Input Voltage	V_{IH}	—	$0.7 \times VDD$	—	VDD	V
Low Level Input Voltage	V_{IL}	—	0	—	$0.3 \times VDD$	V
High Level Output Voltage	I_{OH}	SEG $V_O=VDD-1V$	—	30	—	mA
High Level Input Current	I_I	$V_I=VDD$	-1	—	+1	μA
Input Port Pull-Up Resistance	I_{RPH}	—	—	10	—	K Ω
Dynamic Current Dissipation	I_{DD}	—	—	—	5	mA



3.3.2、AC Characteristics

($T_{amb}=25^{\circ}\text{C}$, $V_{DD}=5\text{V}$, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Communication Clock Frequency	Fosc	SCLK, cycle duty 50%	-	1	-	MHz
Data Set-Up Time	T_{setup}	-	100	-	-	ns
Data Hold Time	T_{hold}	-	100	-	-	ns
Output Voltage Falling Time	T_{THZ}	CL=300pF, SEG	-	-	120	us

4、Function Description

4.1、Communication Interface

AiP33504 provides a simplified IIC communication interface with the following features:

- SCLK and DIN two-wire communication, port built-in 10K Ω pull-up resistance
- same start and stop signs as the standard IIC interface
- no slave address required
- no handshake signal ACK bit is required
- 8 clocks per cycle, high bit first

4.1.1、Start and Stop Flag

AiP33504 will detect Start and Stop flags when the clock signal is at high level.

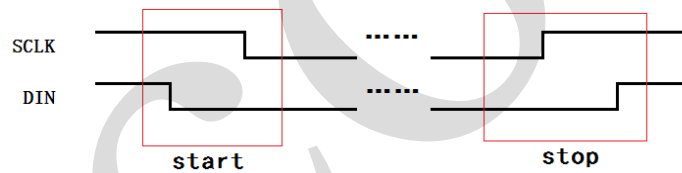


Figure 1. Start and Stop Flag Waveforms

4.1.2、Single-Byte Communication

The data can only be changed when the clock is at low level, otherwise wrong Start and Stop flags will appear. The single-byte communication waveform is shown in the following figure:

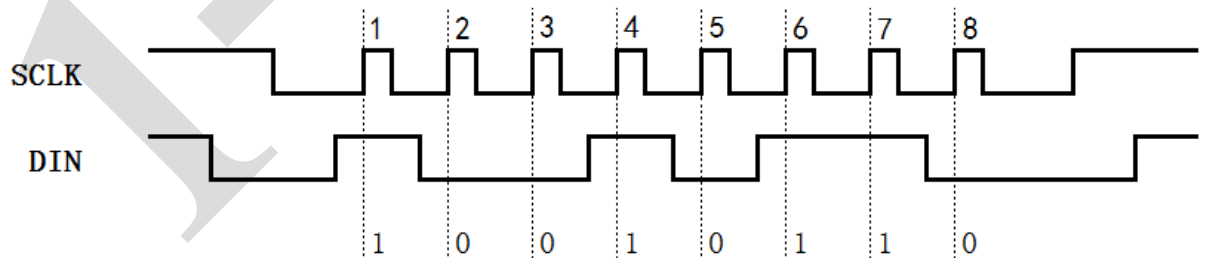


Figure 2. Single-Byte Communication

Data is latched on the rising edge of the clock.



4.1.3、Multi-Byte Communication

Multi-byte continuous communication can be carried out for AiP33504, that is, multiple bytes can be continuously transmitted between a set of Start and Stop flag, as shown in the following figure:

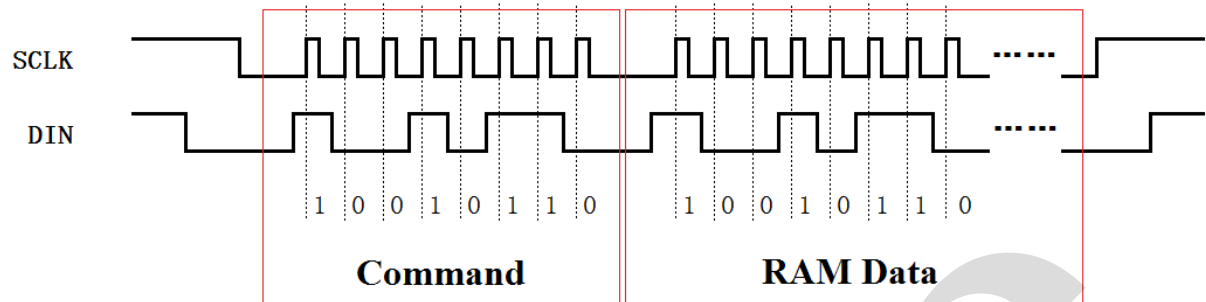


Figure 3. Two or more bytes of communication

In multibyte communication, the first byte is command, and the second byte is RAM data. Starting from the second byte, the data will be stored in RAM from the address of 0x00.

4.2、Instruction System

4.2.1、Instruction Set

AiP33504 provides 4 commands for setting display related functions. The command set is as follows:

No.	Instructiuon	B7	B6	B5	B4	B3	B2	B1	B0
1	Constant Current Setting	0	0	0	CURRENT[4:0]				
2	Aaddressing mode setting	0	1	0	0	0	ADS	0	0
3	Display Setting	1	0	0	0	DIS	G_O	0	0
4	RAM Address Setting	1	1	0	AD1	AD0	0	0	0

4.2.2、Constant Current Setting

No.	Instructiuon	B7	B6	B5	B4	B3	B2	B1	B0
1	Constant Current Setting	0	0	0	CURRENT[4:0]				

CURRENT[4:0]:

Reset value: 00000

Set the magnitude of SEG output constant current, current calculation formula is:

$$I_{SEG} = 6.75\text{mA} + \text{CURRENT} \times 0.745\text{mA}$$

The minimum setting is 00000, and the output instantaneous current is 6.75mA

The maximum setting is 11111, and the output instantaneous current is 29.85mA.

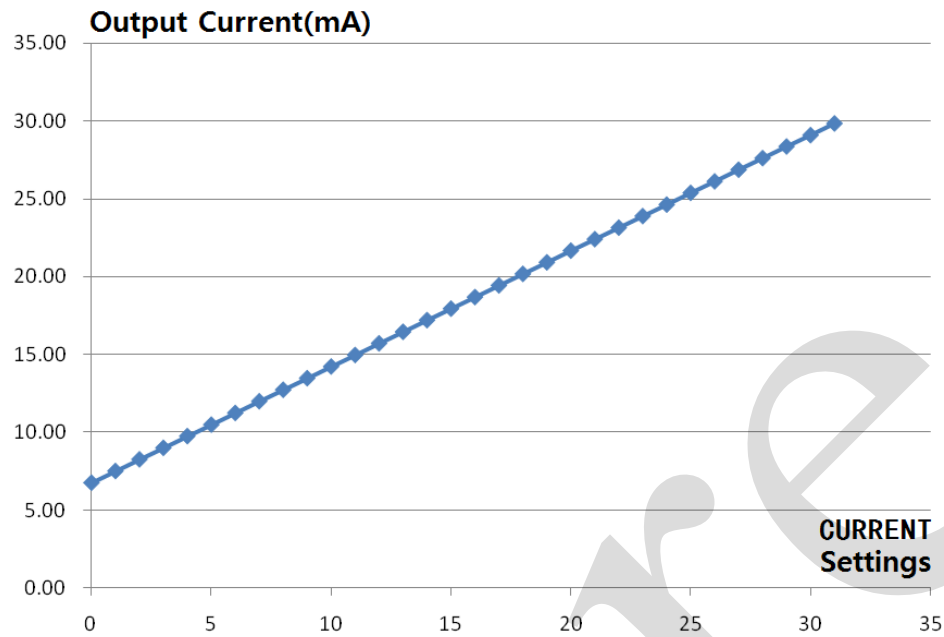


Figure 4. Relationship between CURRENT Setting and SEG Output Current

4.2.3、Aaddressing mode setting

No.	Instructiuon	B7	B6	B5	B4	B3	B2	B1	B0
2	Aaddressing mode setting	0	1	0	0	0	ADS	0	0

ADS:

Reset value: 0

Set 0, when writing to RAM, the RAM address will be automatically increased after writing a byte.

Set 1, the RAM address will not change when writing to RAM. At this time, the RAM address is controlled by AD[1:0] of command number 4.

4.2.4、Display Setting

No.	Instructiuon	B7	B6	B5	B4	B3	B2	B1	B0
3	Display Setting	1	0	0	0	DIS	G_O	0	0

DIS:

Reset value: 0

SEG enable control bit

After setting 1, SEG can be displayed normally (* refer to “4.4、Operation Control Flow” for the process of enabling display)

G_O:

Reset value: 0

SEG port blanking function switch control.

Set 1, start SEG port blanking function



4.2.5、RAM Address Setting

No.	Instruction	B7	B6	B5	B4	B3	B2	B1	B0
4	RAM Address Setting	1	1	0	AD1	AD0	0	0	0

AD[1:0]

Reset value: 00

When ADS=1, AD[1:0] is used to set the operation address of RAM.

When ADS=0, AD[1:0] can be set by communication, but the set value has no effect.

4.3、RAM

AiP33504 circuit has built-in RAM, which is used to store display data.

RAM has 8 bit data for each address. The data of each address is used to control the output duty cycle of one LED. When the data is set to 0x00 in the RAM, the duty cycle of the corresponding LED lighting time is 0/257; When the data is set to 0xFF in the RAM, the duty cycle of the corresponding LED lighting time is 255/257.

The corresponding relationship between RAM address and LED dot matrix is as follows:

AD[1:0]	Corresponding output port
00	SEG1
01	SEG2
10	SEG3
11	SEG4

The corresponding relationship between the data in RAM and the duty cycle of LED lighting time:

Data in RAM	Corresponding LED Lighting Time Duty Cycle
0x00	0/257
0x01	1/257
0x02	2/257
.....	
0xFE	254/257
0xFF	255/257

If ADS is set to 0, the RAM address of each write operation must start from 0x00, and the RAM address will be automatically increased by 1 after each address is written.

Because AiP33504 has 256 steps of PWM adjustment ability, the use of gamma correction effect to control the PWM duty cycle change, can manually achieve the control effect similar to breathing light. This results in a reduced number of steps for the LED intensity setting, but causes the change in intensity to appear more linear to the human eye.

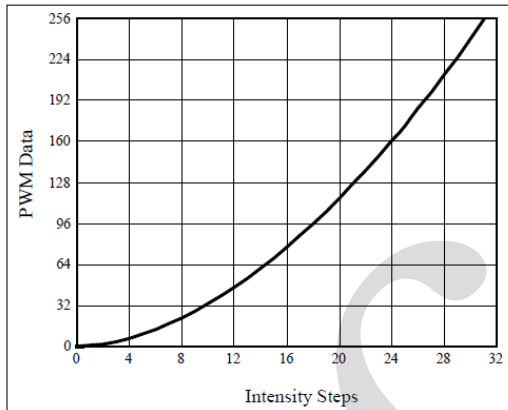
GAMMA correction, also known as GAMMA compression or encoding, is used to encode linear luminance to match the non-linear characteristics of display. Since AiP33504 has the function of adjusting PWM point by point, a GAMMA correction function can be applied when computing each subsequent LED intensity setting such that the changes in brightness matches the human eye's brightness curve.

Choosing more gamma steps provides for a more continuous looking breathing effect. This is useful for very long breathing cycles. The recommended configuration is defined by the breath cycle T. When T=1s, choose 32 gamma steps, when T=2s, choose 64 gamma steps. The user must decide the final number of



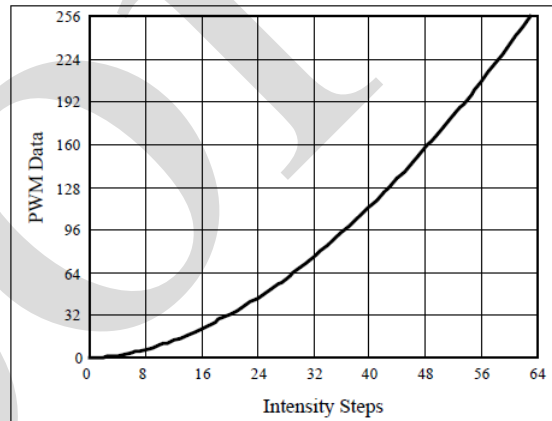
gamma steps not only by the LED itself, but also based on the visual performance of the finished product. A breathing cycle refers to the time taken to complete a change from the darkest to the brightest (or vice versa).

C(0)	C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)
0	1	2	4	6	10	13	18
C(8)	C(9)	C(10)	C(11)	C(12)	C(13)	C(14)	C(15)
22	28	33	39	46	53	61	69
C(16)	C(17)	C(18)	C(19)	C(20)	C(21)	C(22)	C(23)
78	86	96	106	116	126	138	149
C(24)	C(25)	C(26)	C(27)	C(28)	C(29)	C(30)	C(31)
161	173	186	199	212	226	240	255



Gamma Correction (32 Steps)

C(0)	C(1)	C(2)	C(3)	C(4)	C(5)	C(6)	C(7)
0	1	2	3	4	5	6	7
C(8)	C(9)	C(10)	C(11)	C(12)	C(13)	C(14)	C(15)
8	10	12	14	16	18	20	22
C(16)	C(17)	C(18)	C(19)	C(20)	C(21)	C(22)	C(23)
24	26	29	32	35	38	41	44
C(24)	C(25)	C(26)	C(27)	C(28)	C(29)	C(30)	C(31)
47	50	53	57	61	65	69	73
C(32)	C(33)	C(34)	C(35)	C(36)	C(37)	C(38)	C(39)
77	81	85	89	94	99	104	109
C(40)	C(41)	C(42)	C(43)	C(44)	C(45)	C(46)	C(47)
114	119	124	129	134	140	146	152
C(48)	C(49)	C(50)	C(51)	C(52)	C(53)	C(54)	C(55)
158	164	170	176	182	188	195	202
C(56)	C(57)	C(58)	C(59)	C(60)	C(61)	C(62)	C(63)
209	216	223	230	237	244	251	255



Gamma Correction (64 Steps)

Figure 5. Gamma Correction



4.4、Operation Control Flow

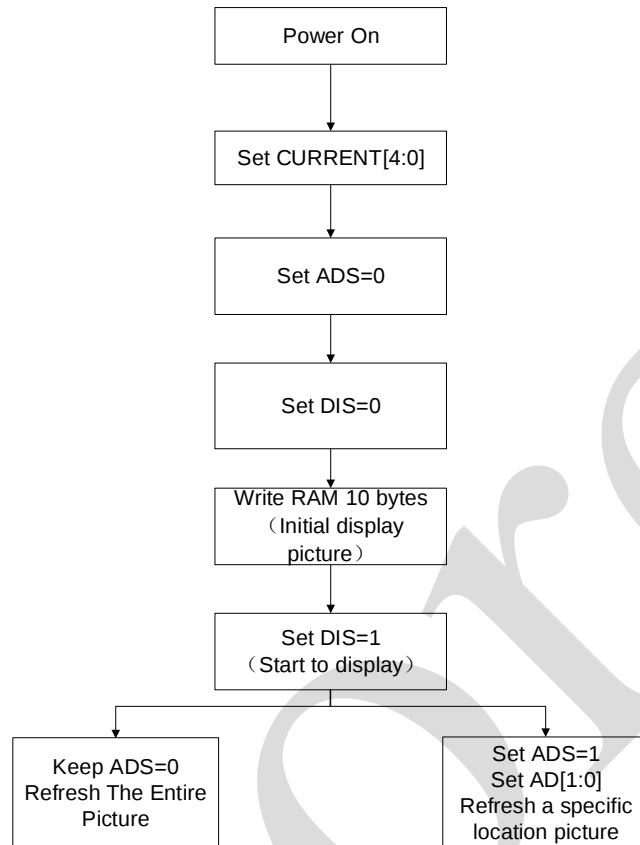
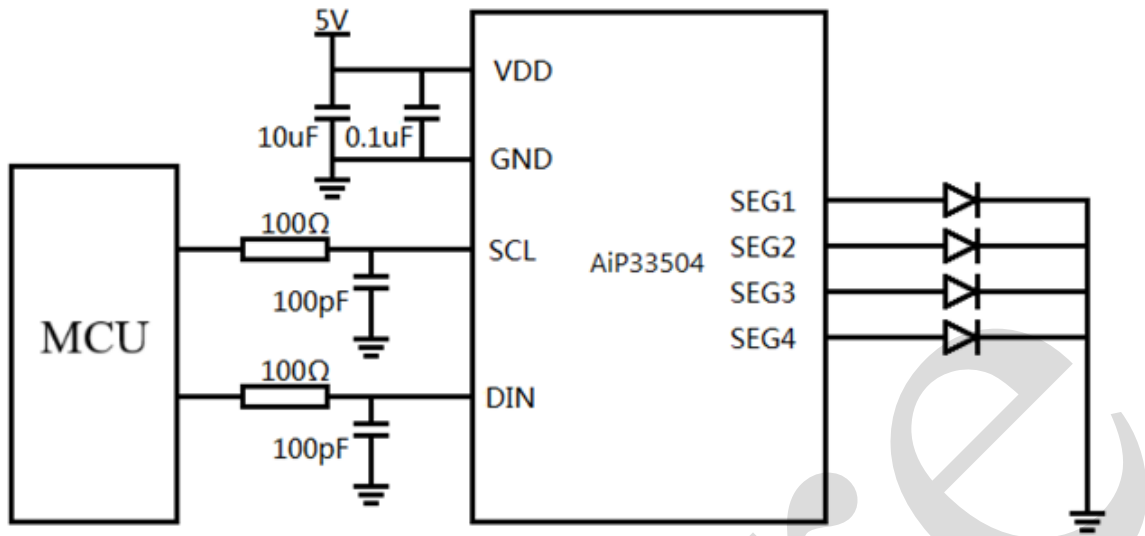


Figure 6. Recommended power on configuration process

In order to prevent the random display of LED dot matrix in the process of power on, AiP33504 has a certain prevention mechanism, which requires that 10 addresses of the entire RAM space must be filled when initializing the display graphics in the control process.



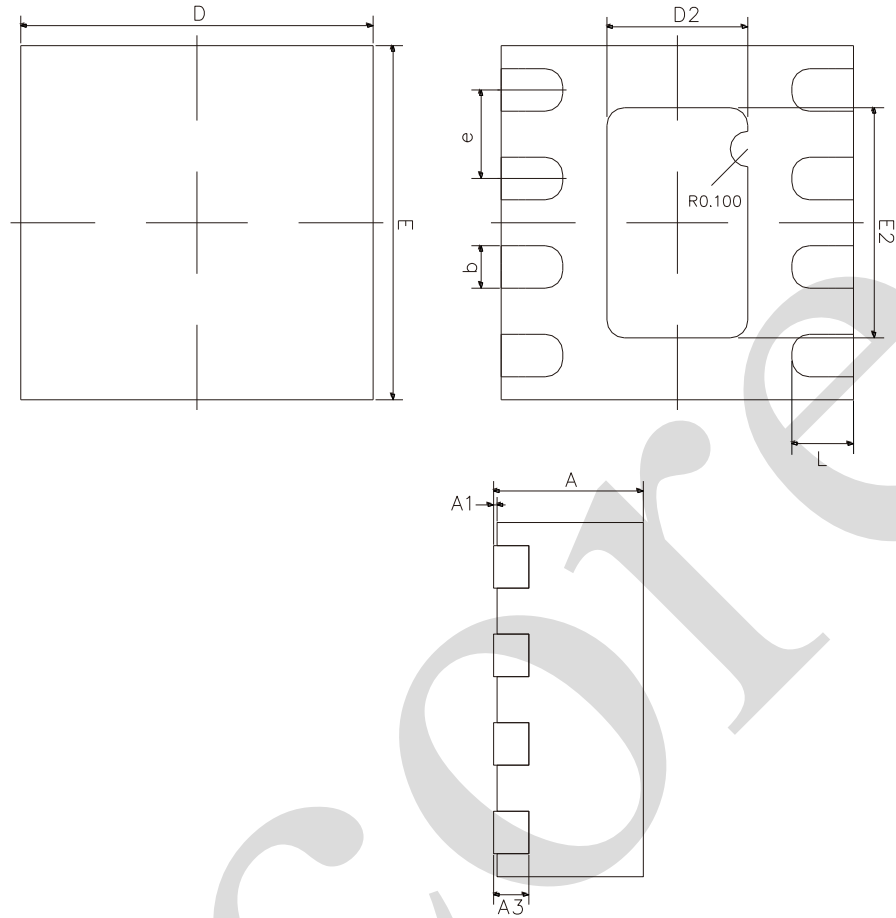
5、Typical Application Circuit And Application Note





6、Package Information

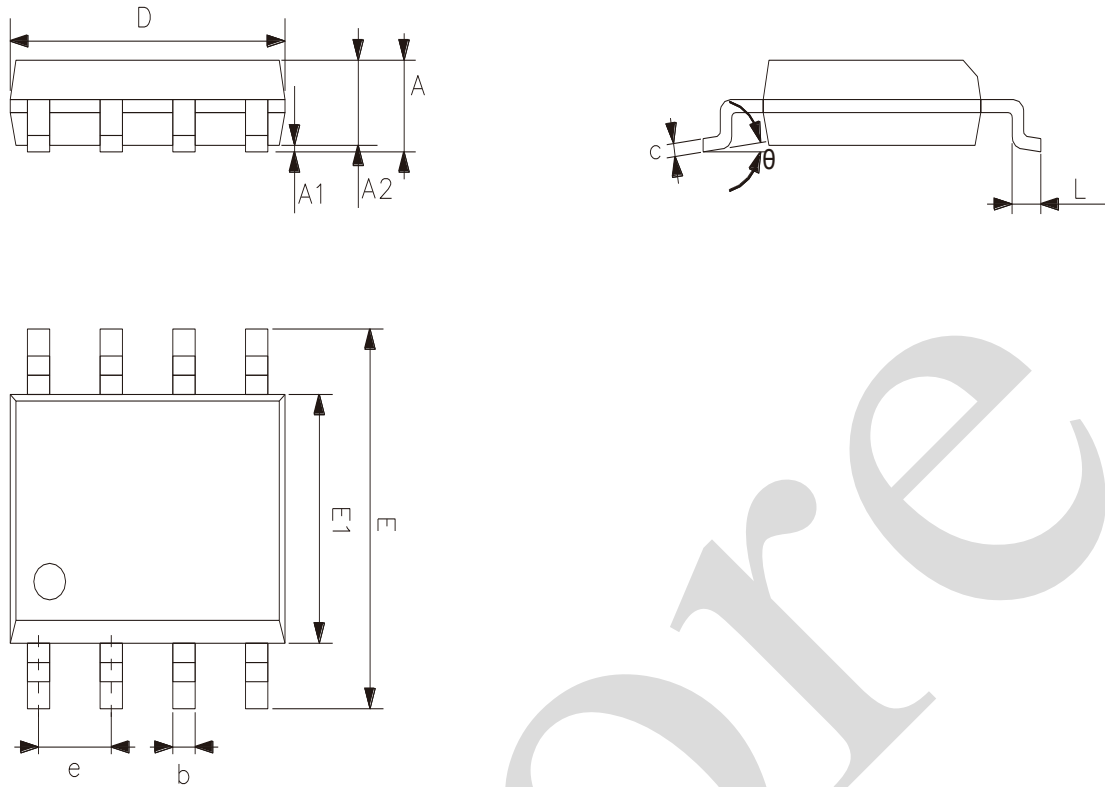
6.1、DFN8



2023/12/A	Dimensions In Millimeters	
Symbol	Min	Max
A	0.70	0.80
A1	0.00	0.05
A3	0.20	
b	0.19	0.30
D	1.90	2.10
E	1.90	2.10
D2	0.60	0.85
E2	1.10	1.35
e	0.50	
L	0.30	0.40



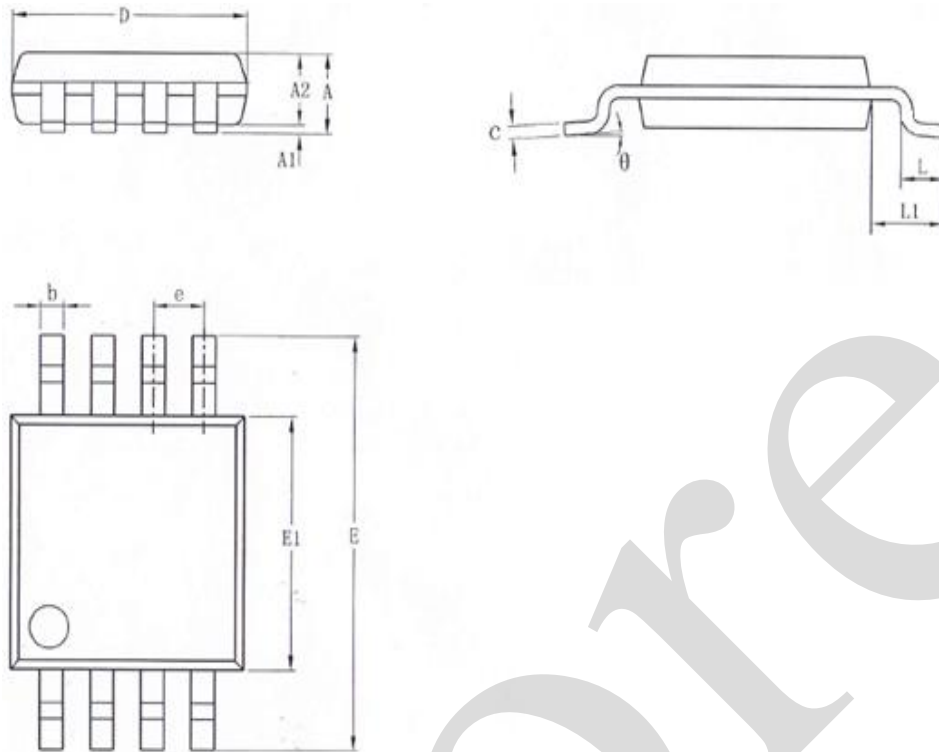
6.2、SOP8



2023/12/A	Dimensions In Millimeters	
Symbol	Min.	Max.
A	1.35	1.80
A1	0.05	0.25
A2	1.25	1.55
D	4.70	5.10
E	5.80	6.30
E1	3.70	4.10
b	0.306	0.51
c	0.19	0.25
e	1.27	
L	0.40	0.89
θ	0°	8°



6.3、MSOP8



2023/12/A	Dimensions In Millimeters	
Symbol	Min	Max
A	—	1.10
A1	0.05	0.15
A2	0.75	0.95
b	0.22	0.38
c	0.08	0.23
D	2.90	3.10
E	4.70	5.10
E1	2.90	3.10
e	0.65	
L	0.40	0.80
L1	0.95	
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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