Function description:

Lianxinke intelligent automatic coding series adopts the patented technology of intelligent multi-algorithm error identification of coding line, which realizes full-time automatic coding stably and reliably. It also supports 0-field function prototype IC application and no coding is required after the lamps are delivered. The engineering installation and after-sales maintenance are simple and convenient, and different series of ICs in the intelligent automatic coding series can be mixed in the lamps for automatic coding. UCS512H series uses DMX512 differential parallel protocol LED driver chip, and supports 1/2/3/4-field high-precision constant current output and 65536 grayscale levels. UCS512H series adopts the gray-scale smoothing function developed by the second-generation adaptive micro-frequency conversion technology to maximize the low-gray and jitter-free effect. The refresh rate of up to 32K ports improves the shooting effect, and the address line detection mode can quickly locate the lamps with address line failures. The chip provides 4 high-precision constant current output channels of 120mA. The output size of the current can be set by an external resistor, and the current of each channel can be independently adjusted by 64 levels through software.

Features:

- Compatible and extended DMX512 (1990) signal protocol;
- Control mode: differential parallel connection, supports up to 4096 channels
- High-precision decoding, fully adaptive decoding of DMX512 signals with a signal transmission rate of 200K ~ 750kbps
- Built-in million times high-quality E2

- UCS512H4/UCS512H4L/UCS512H5L/UCS512H0L features differential transmission, 65536 grayscale levels, and gamma 2.2 correction
- UCS512HL uses single bus transmission, 65536 grayscale levels, and gamma 2.2 correction
- W channel triple current mode (UCS512H4 only)
- PWM selection terminal allows choosing reverse polarity function, which does not change the port refresh rate when this function is implemented (UCS512H4 only)
- R/G/B/W 4-bit constant current output channel, ±5% high-precision current difference between chips
- UCS512H4/UCS512HL set the current to 10mA-120mA through the external resistor
- UCS512H4L/UCS512H0L default current is 18mA, UCS512H5L default current is 26mA
- Built-in 5V voltage regulator, 28V output dielectric strength
- Built-in patented S-AI anti-jamming module greatly enhances the anti-jamming ability
- 80nS output channel hysteresis reduces inrush current interference
- Industrial grade design, stable performance

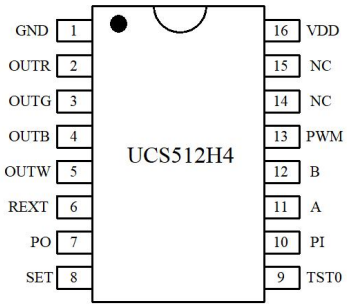
- Field mode: 1/2/3/4
- Port refresh rate: 250HZ 4K 8K 32K
- Optional reverse polarity port delay: 0-1860nS 32 levels 60nS per level
- Lights up when power on: Address line detection mode Custom grayscale
- Current level: 1-64
- Grayscale smoothing function: The second-generation adaptive micro-frequency conversion grayscale smoothing patented technology maximizes low grayscale and no jitter
- 0 field mode: Made into prototype (ordinary lamp or put into connector lug), address of the first lamp is written when delivered (usually address 1, or others), put in front of the first lamp during engineering installation, and send its address to the first lamp through automatic coding function, which solves the problem of automatically obtaining the address of the first lamp. Only UCS512H0L uses this mode

- Intelligent automatic coding: Intelligent patented technology, achieves full-time automatic coding stably and reliably without manual operation, simplifies engineering installation and after-sales;
  Before sending address and parameters, intelligent multi-algorithm error identification avoids sending wrong data due to internal IC errors
  After receiving address and parameters, intelligent multi-algorithm error identification detects the address and operating parameters of the previous IC, and stores and uses this address only when the address and the operating parameters of the previous IC are judged to be normal.
  Compatible with UCS512G series and UCS512K series

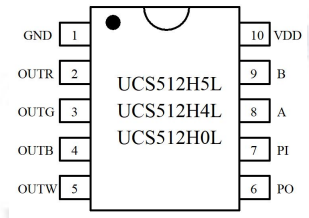
- Note: UCS512H0L uses 0 field mode. Other parameters and functions are consistent with UCS512H4L

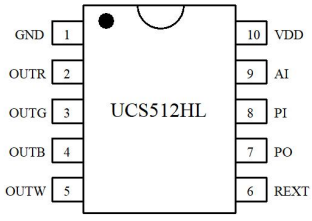
Pin diagram:

SOP16



SOP10:





Pin description

	UCS512H4	
No.	Symbol	Function description
1	GND	Ground
2~5	RGBW	PWM output port
6	REXT	Constant current feedback terminal, resistor connected to ground to adjust the output current.
7	PO	Address coding line output
8	SET	Floating, normal mode; grounding, W current is 3 times REXT setting current
9	TST0	Test pin
10	PI	Address coding line input, built-in pull-up
11	A	Differential signal, positive, built-in pull-up
12	B	Differential signal, negative, built-in pull-down
13	PWM	Output polarity selection, generally floating, output polarity is opposite after connecting to VDD. Port refresh rate isn't changed when the polarity is reversed
14	NC	Not connected
15	NC	Not connected
16	VDD	Power terminal, built-in 5V voltage regulator

	UCS512H4L/UCS512H5L/UCS512H0L	
No.	Symbol	Function description
1	GND	Ground
2~5	RGBW	PWM output port
6	PO	Address coding line output
7	PI	Address coding line input, built-in pull-up
8	A	Differential signal, positive, built-in pull-up
9	B	Differential signal, negative, built-in pull-down
10	VDD	Power terminal, built-in 5V voltage regulator

	UCS512HL	
No.	Symbol	Function description
1	GND	Ground
2~5	RGBW	PWM output port
6	REXT	Constant current feedback terminal, resistor connected to ground to adjust the output current.

7	PO	Address coding line output
8	PI	Address coding line input, built-in pull-up
9	AI	Bus signal terminal
10	VDD	Power terminal, built-in 5V voltage regulator

Maximum limit value (unless otherwise specified, Ta=25°C, Vdd=5V)

Parameter	Symbol	Scope	Unit
Logic supply voltage	V_{dd}	-0.5~+6	V
Logic input voltage	V_i	−0.5~Vdd+0.5	V
Output port dielectric strength	V_{out}	30	V
RGBW output maximum current	I_{out}	120	mA
VDD maximum clamp current	I_{damp}	25	mA
Operating junction temperature	T_j	−45~+150	°C
Storage temperature	T_{stg}	−55~+150	°C
Thermal resistance from PN junction to ambient (SOP16)	RθJA	90	°C /W
Thermal resistance from PN junction to ambient (SOP10)	RθJA	125	°C /W
Maximum power consumption (SOP16)	P_d	900	mW
Maximum power consumption (SOP10)	P_d	600	mW
Antistatic	ESD	6000	V

Note 1: The maximum limit value means that the chip may be damaged beyond the working range. When operating within the parameter limits, the device will function properly, but individual performance specifications can't be fully guaranteed.

Note 2: RθJA is measured on a single-layer thermally conductive test board according to JEDEC JESD51 thermal measurement standard at TA=25°C natural convection.

Note 3: The maximum power consumption is limited by the chip junction temperature. The maximum output power will decrease when the ambient temperature increases, which is also determined by the junction temperature T_{JMAX}, the ambient temperature T_A and RθJA. The maximum allowable power consumption is $P_D = (T_{JMAX}-T_A)/R\theta JA$ or the lower of the values given in the limits

Recommended working range (unless otherwise specified, Ta=−40~+85°C, Vdd=5V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions
Logic supply voltage	Vdd	3	5	5.5	V	-

Electrical parameters (unless otherwise specified, Ta=−40~+85°C, GND=0V, Vdd=4.5~5.5V)

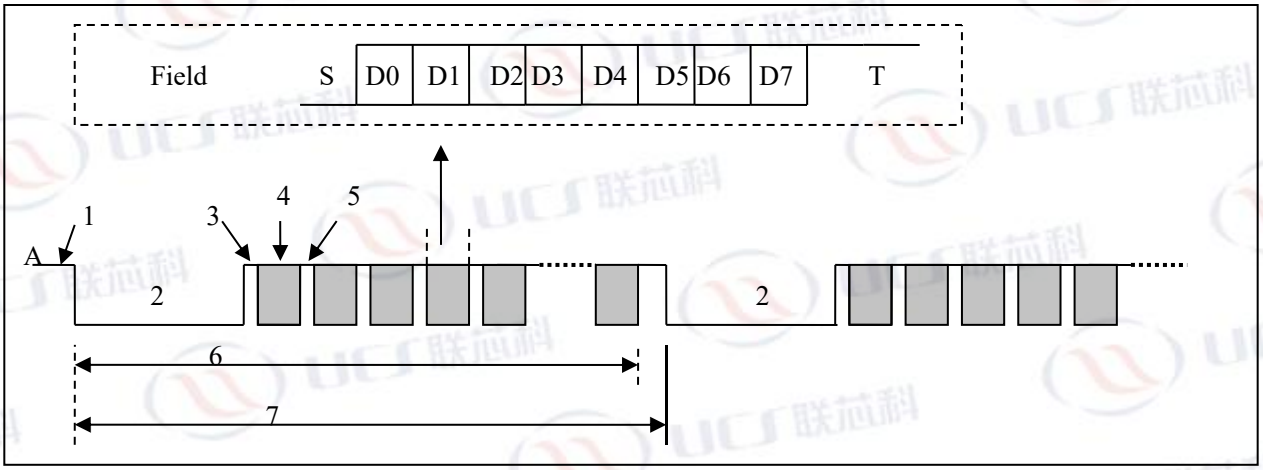
Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions
Clamping voltage	V_{dd}	4.8		5.5	V	V_{in}=12V, step-down resistor 1K
Dynamic current consumption	I_{DDdyn}		3		mA	Po close
High level output current	I_{poh}		17		mA	V_{po} = 4 . 6 V
Low level output current	I_{pol}		25		mA	V_{po} = 0.4 V
High level input voltage	V_{ih}	0.7 V_{dd}			V	D_{PI}/D_{AI} high level
Low level input voltage	V_{il}			0.3 V_{dd}	V	D_{PI}/D_{AI} low level
Differential input common mode voltage	Vcm	-7		12	V	V_{dd}=5V
Differential input current	I_{AB}			28	uA	V_{dd}=5V
Differential input threshold voltage	Vth	-0.2		0.2	V	V_{dd}=5V
Differential input hysteresis voltage	△VTH		70		mV	V_{dd}=5V
Port A/B pull-down resistor	R_{downAB}		190		KΩ	V_{dd}=5V
Port-A pull-up resistor	R_{upA}		800		KΩ	V_{dd}=5V
Output port knee point voltage	Vds-s		0.4		V	R/G/B/W=20mA
Output port knee point voltage	Vds-s		0.8		V	R/G/B/W=80mA
Output port knee point voltage	Vds-s		1.4		V	R/G/B/W=120mA
Current offset (inter-chip)	D_{Iout}			±5.0	%	Vds=1V, Iout=60mA
OUT output current change	%dVds		±0.5		%/V	1V<Vds<3V
	%dVdd		±1.0		%/V	4.5V<Vdd<5.5V
	%dT_A		±3.0		%/°C	T_A=-40~+85°C
Over-temperature protection port shutdown threshold	OTP_{off}		150		°C	4.5V<V_{dd}<5.5V
Over-temperature protection port open threshold	OTP_{on}		110		°C	4.5V<V_{dd}<5.5V

Switching characteristics (unless otherwise specified, Ta=−40~+85°C, Vss=0V, Vdd=4.5~5.5V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test conditions
Port refresh rate	F_{pwm1}		8		KHz	I_{OUT}=80mA, PWM parameter is 8K, PWM pin floating
	F_{pwm2}		8		Hz	I_{OUT}=80mA, PWM parameter is 8K, PWM pin connected to VDD
Data transfer rate	F	200		750	Kbps	

Communication data protocol:

UCS512H series data reception is compatible with standard DMX512 (1990) protocol and extended DMX512 protocol, data transmission rate is 200kbps to 750K adaptive decoding. The protocol waveform is as follows: the chip uses AB differential input, the timing waveform of A is drawn in the figure, and B is opposite to A.



Mark	Description	Min.	Typ.	Max.	Unit
	Bit rate	200	250	500	Kbps
	Bit time	5	4	2	us
S	Start bit	5	4	2	us
D0~D7	Data bits	5	4	2	us
T	2 stop bits	10	8	4	us
1	Mark before reset	0		1000000	us
2	Reset signal	88		1000000	us
3	Mark after reset	8		1000000	us
4	Field (note1)	55	44	22	us
5	Space between fields	0		1000000	us
6	Length of packet	1024		1000000	us
7	Reset signal interval	4096		1000000	us

Note1: The field has a total of 11 bits, including 0 start bit, 8 data bits and 2 stop bits. The 0 start bit is low level, and the stop bits are high level. If the data in the data bit is 0, the corresponding time period is low level; if it is 1, the corresponding time period is high level. 0 start bit, stop bits and data bits must have the same bit length

Function description

Coding instructions

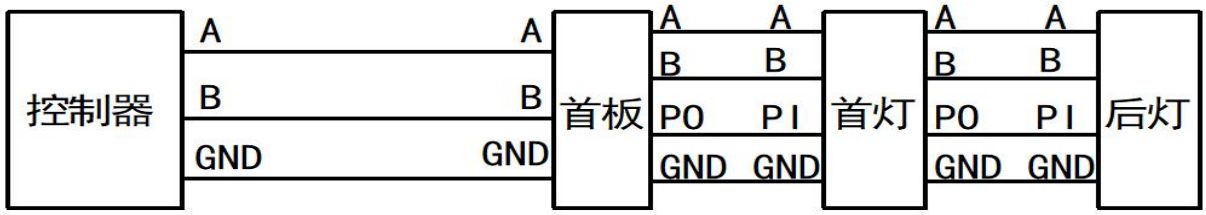
Automatic coding: When the automatic coding is turned on, the controller does not need to send a coding command. After power-on, the IC will automatically send the coding data to the following lamps. The automatic coding adopts the patented technology of intelligent multi-algorithm error identification, which can effectively avoid receiving wrong addresses and greatly simplify the problem of engineering installation and after-sales maintenance. There is no need to write codes during the whole process of engineering installation. After the replacement of the faulty lamps, the new lamps will automatically get the valid addresses immediately.

To completely eliminate the need of coding in engineering application, it is necessary to solve the problem of how to obtain the address of the first lamp (PI floating) after the installation. If the first lamp obtains the correct address, the following lamps can get the addresses through automatic coding in turn. The first lamp can get the address in the following three modes:

1. It is used with prototype IC in the project. Placed in front of the first lamp, the prototype (prototype IC uses UCS512H0L) can be a common lamp or a special connector (built-in UCS512H0L). The first lamp of UCS512H series obtains the required address from the prototype, and the address of the prototype is written as the address of the first lamp in advance (usually address 1, or others). There is no need to write the address before and after the installation. Note: Misplacement of the prototype of UCS512H0L between lamps will not affect the normal operation of lamps and automatic coding
2. Prototype isn't used. In the project, the first lamp is written as the required address by manual coding, and the subsequent lamps get the addresses by automatic coding. The disadvantage of this plan is that one coding is required after installation.
3. Before the lamps are delivered, the addresses of all lamps are uniformly written as the address of the first lamp (usually address 1) through the parallel address writing function. The disadvantage of this plan is that pattern and re-powering are not allowed after parallel address writing. Otherwise, the addresses will be rearranged by automatic coding, and the addresses written by parallel coding can't be maintained, which requires high production management.

Through the comparison of the above three plans, it is obvious that using first plan and prototype is the simplest to debug after installation. No coding is required at all, and there are no special requirements for production management.

Schematic diagram of prototype application



Manual coding:

1. Cascade code writing: Conventional coding method, write different addresses to each IC, but ensure that the coding line is normal
2. Parallel code writing: All ICs on a bus are written to the same address, and the address writing isn't affected even if the coding line is faulty. After writing, the automatic coding will not start, but will start after booting or powering on again (automatic coding is turned on)

Description of parameter writing

The UCS512H series has 2 parameter writing modes: cascade and parallel

Advantages and disadvantages of cascade parameter write: write different parameter values to each IC, but ensure that the coding line is normal

Advantages and disadvantages of parallel parameter write: The same parameter values can be written to all ICs on one bus only, and the failure of the coding line does not affect the parameter writing

Preferences

Number of fields: 1 2 3 4
Automatic coding: On Off
Grayscale smoothing mode: On Off
Anti-jamming when powered on: On Off
Reverse polarity port delay: 0-1860nS 32 levels 60nS per level
Power-on lighting status: Address line detection mode Grayscale custom mode
1.5S no signal lighting status: Light up when resume power-on Keep the last frame
Port refresh frequency selection: 250HZ 4K 8K 32K
Current level: 1-64

Lighting of parameter writing: (black if unsuccessful)

<table>
<tr><td rowspan="2">Address parameter writing</td><td colspan="2">Successful</td><td>Unsuccessful</td></tr>
<tr><td>Parallel</td><td>Cascade</td><td rowspan="3">Black</td></tr>
<tr><td>Address is 1: R
Address is not 1: G</td><td>First lamp: RG
Non-first lamp: RGBW</td></tr>
<tr><td>Power-on light up + no signal light up + port refresh rate</td><td colspan="2">Address line detection mode valid:
Automatic coding off: all lamps are yellow
Automatic coding on: before the prototype is added, the first lamp is yellow, and the followings are red
After the prototype is added in front of the first lamp, the first lamp is blue, and the followings are red
Address line detection mode off: Custom grayscale</td></tr>
<tr><td>Automatic coding</td><td>Writing on: RB</td><td>First lamp: RG</td></tr>
</table>

	Writing off: RGBW	Following lamp writing on: RB Following lamp writing off: RGBW	
Field Grayscale smoothing Reverse polarity port delay Power-on lighting anti-jamming Current level	RGBW	First lamp: RG Following lamp: RGBW	

Note 1: The above lighting grayscales are all 22%

Description of power-on self-test

Address line detection mode: When the address line detection mode is enabled

Automatic coding off: yellow lamp on

Automatic coding on: before the prototype is added, the first lamp is yellow, and the followings are red

After the prototype is added in front of the first lamp, the first lamp is blue, and the followings are red

When there is a fault in the coding line (whether a short circuit or other faults), the yellow lamp will turn on, and the yellow lamp or red/blue lamp will change instantly with the fault situation. If the lamp color changes irregularly, it means that there is a hidden fault. The address line detection mode is mainly used with automatic coding, and the fault point of the address line is visually displayed through the lamp indicator.

Custom grayscale mode: Grayscale values can be set for each port independently

Field mode

Mode	Effect
1-field mode	Receive data of 1 channel (field), corresponding to RGBW
2-field mode	Receive data of 2 channels (fields), corresponding to RG, BW
3-field mode	Receive data of 3 channels (fields), corresponding to R, G, B; W off
4-field mode	Receive data of 4 channels (fields), corresponding to R, G, B, W

Note: The selection of different field modes in the above table affects the interval of automatic coding address and must be set correctly

Description of W triple current mode:

Set pin “W” triple current mode through SET pin

SET pin floating: W pin output current = REXT resistance setting current * software setting ratio

SET pin connected to GND: W pin output current = REXT resistance setting current * 3 * software setting ratio

Grayscale smoothing mode: With patented second-generation micro-frequency conversion grayscale smoothing technology, the grayscale changes are softer, and the low grayscale changes are smooth without jitter.

Reverse polarity port delay: Constant current driver IC is generally connected in reverse polarity applications. In order to prevent the constant current driver IC from being turned on at the lowest gray level, the reverse polarity port delay function is designed, and the delay time is 0-1860nS, 32 levels optional, 60nS per level. Appropriate delay time can be set according to the minimum response time of the external constant current driver IC to adjust the brightness of the graying.

Series	Time (nS)	Series	Time (nS)	Series	Time (nS)	Series	Time (nS)
1	0	9	480	17	960	25	1440
2	60	10	540	18	1020	26	1500
3	120	11	600	19	1080	27	1560
4	180	12	660	20	1140	28	1620
5	240	13	720	21	1200	29	1680
6	300	14	780	22	1260	30	1740
7	360	15	840	23	1320	31	1800
8	420	16	900	24	1380	32	1860

Project installation and debugging under the condition of using automatic coding function

1. After installation, first perform the overall gradient test to repair the fault.
   Note: It is recommended to set the number of control channels of the controller (number of distribution channels) to 1536 or more. The maximum address of UCS512H series is 1501 in the state of automatic coding. If the address exceeds 1501, the default address is 1501. Therefore, as long as the controller sends data by channel 1536 or above, the UCS512H series lamps will not be out of control due to the existence of a larger address.
2. Color wash or run point by point. There is no need to stop the screen and power off when encountering a fault. Simply replace the lamp, and the replaced lamp will automatically get the address and display the correct screen. This process does not require recoding or disconnecting power, and generally does not require the presence of professional engineering after-sales personnel. To display the fault point more intuitively, please close the screen to activate the address line detection mode (IC factory default), and the fault point can be visually displayed through the lighting state.
3. If the controller has not arrived after installation, it can be debugged first. If the power-on lighting parameters have not been modified from the default values of the IC, the address line detection mode will be displayed after power-on. The lamps with address line failure can be eliminated first through the lighting state.

After-sales maintenance using automatic coding function

Generally, the construction party has spare lamps. After debugging, there may be defect lamps, and the construction party can simply replace the defect lamps with the spare lamps. There is no need to rewrite the code or power off. The operation is simple and there is no need for professionals to be present

S-AI anti-jamming patented technology: One of our patented technologies, used in high-speed communication interface IC; it filters out a certain range of differential mode jamming signals through an embedded algorithm module, which can complement the common mode anti-jamming ability of the differential bus to a certain extent and expand the anti-interference ability. It is suitable for the engineering environment with large jamming, and also suitable for products with large jamming such as switching high-power constant current drive modules.

Default parameter values of UCS512H series:

Parameter name	UCS512H4L/512H5L/512HL	UCS512H0L
Number of fields	4	4
Grayscale smoothing mode	Off	Off
Automatic coding	On	On
Port-A anti-jamming mode	On	On
Reverse polarity port delay	No	No
Power-on lighting mode	Address line detection mode	Address line detection mode
Port refresh rate	4K	4K
1.5S no signal state	Light up when resume power-on	Light up when resume power-on
Current level	Maximum	Maximum

Note: Other functions and features of UCS512H0L and UCS512H4L are the same. The only difference is that UCS512H0L uses 0 field mode, while UCS512H0L is only used as prototype.

Output constant current setting:

R, G, B, W are constant current output, and the constant current value is determined by the resistance of REXT to ground. Current formula:

I=256/Rext (1)

Rext=256/I (2)

Rext is a resistor connected across the REXT pin and ground, and I is the current output by the R, G, B, and W ports.

For example: to get a current of 30mA, use the formula (2) Rext=256/30mA, and finally get Rext=8.5K.

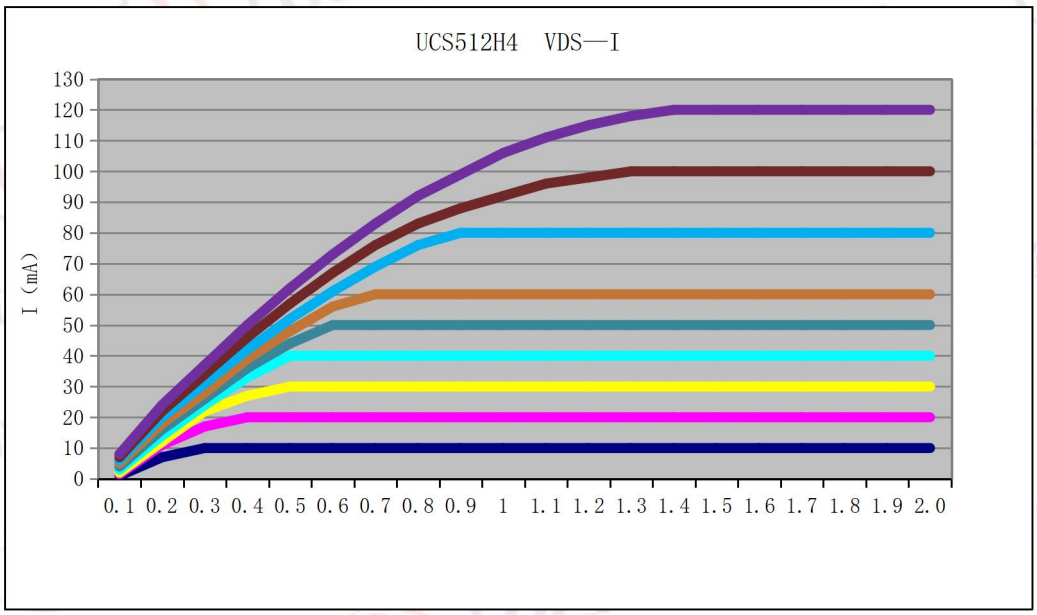
Constant current curve:

UCS512H series has excellent constant current characteristics and the current difference between channels and even between chips is extremely small.

(1): The maximum current error between channels is ±3%, and that between chips is ±5%.

(2): When the load terminal voltage changes, the output current is not affected, as shown in the figure below

(3): It is known from the relationship between the current I of the output port and the voltage Vds applied to the port shown in the figure below that the smaller the current I, the smaller the Vds required in the constant current state.



Voltage divider resistance:

Power consumption calculation: Take the 4-channel output with a constant current of 60mA per channel as an example, if the voltage drop (Vds) of each output pin of the IC is set to 2V, the power consumption at the highest grayscale output on the IC is:

$P=P_{RGB}+P_{VDD}=4*2V*60mA+5V*10mA=0.48+0.05=0.53W$

$Vds\text{-}max = (P_{MAX}-0.05)/(I*N)$

Vds-max is the highest voltage on the output port of the IC, and P_{MAX} is the maximum power consumption of the IC

The maximum power consumption is related to the IC package capacity and the heat dissipation capacity of the lamp and the ambient temperature

I is the current value, and N is the number of ports used.

Calculation of voltage divider resistance:

$VCC—K*V_{led\text{-}min}—VR< Vds\text{-}max$

VR=I*R R is the voltage divider resistance

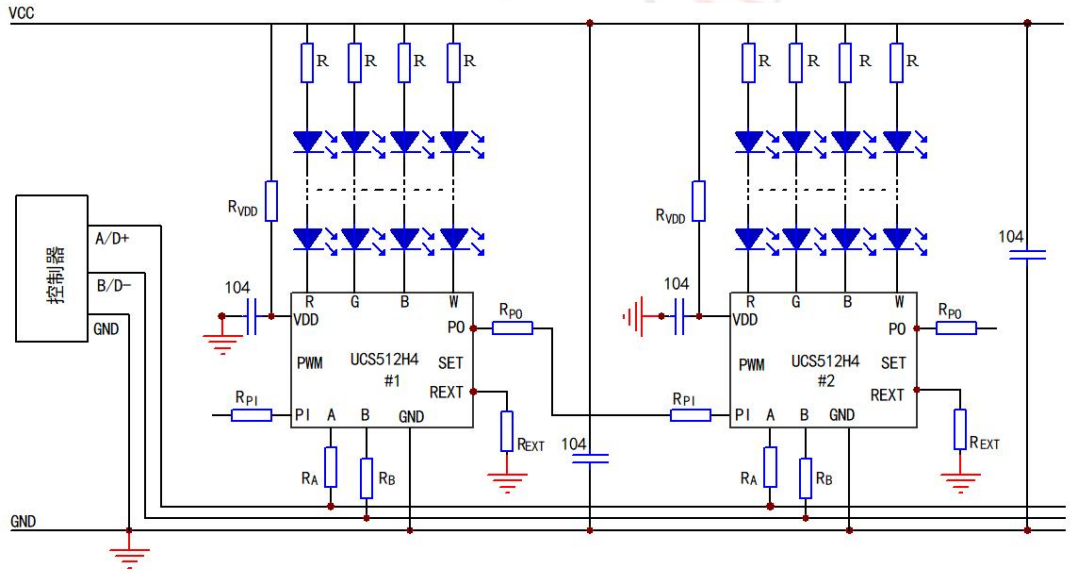
$R > (VCC—K*V_{led\text{-}min}—Vds\text{-}max)/I$

VCC is the power supply voltage, Vled-min is the minimum turn-on voltage of the lamp beads, K is the number of lamp beads in series, Vds-max is the maximum voltage of each output pin, and I is the set constant current value.

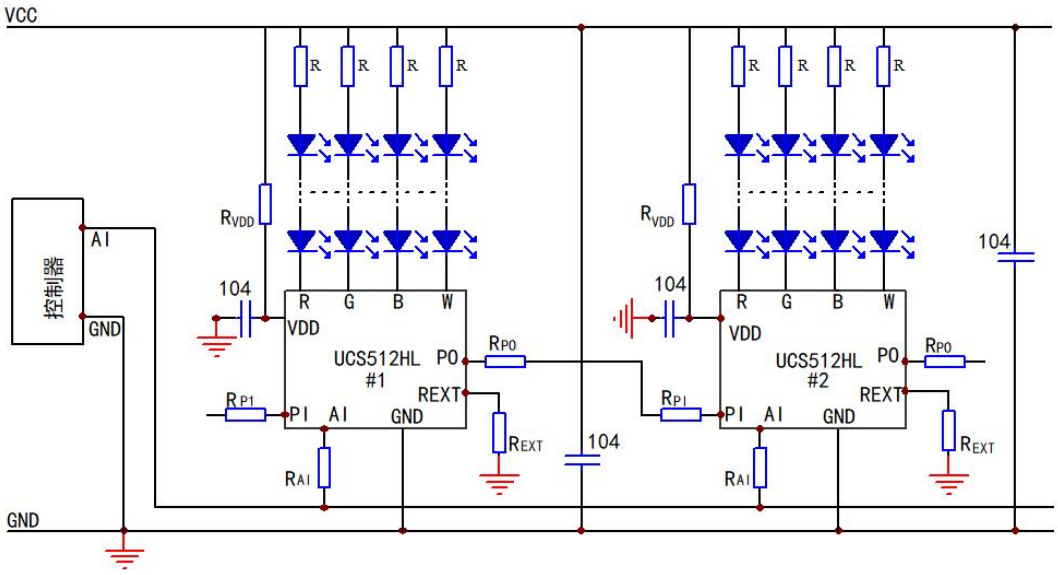
Note: The power consumption should be considered when selecting the voltage divider resistor

Application diagram

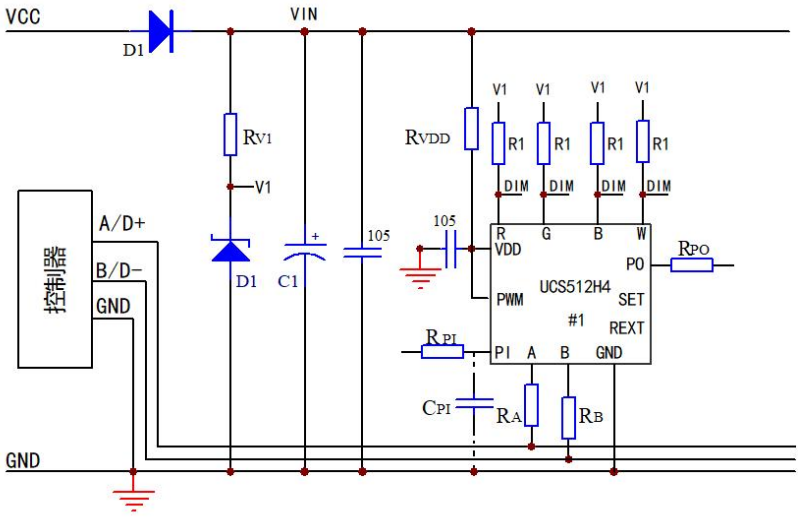
1. Direct drive LED application (UCS512H4)



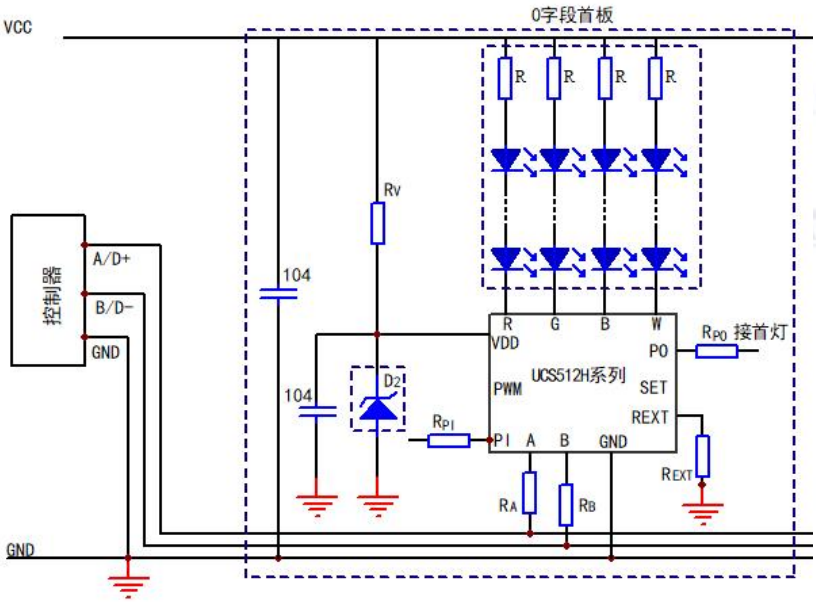
2. Direct drive LED application (UCS512HL)



3. Reverse polarity application - external constant current driver IC (UCS512H4)



4. 0-field prototype application



Note 1: UCS512H series in the above figure refers to UCS512H0L, which is used as the prototype generally

Note 2: In the dotted box is the 0-field prototype application scheme. The D2 is added in the application to be compatible with 12V/24V power supply. If there is no need to make prototype compatible with 12V and 24V, there is no need to use D2. At this moment, the value of step-down resistor is the same as RVDD. When the power supply is 5V, D2 should be cancelled, and the value of the step-down resistor should be 100 ohms.

Note 3: The lamp beads are framed by dotted lines, which mean that the lamp beads are optional, and the prototype itself does not need to be lit.

Component value table:

Component	24V	12V	5V

R_{VDD}	2K	750	100
R_{PI}	500	500	500
R_{PO}	500	500	500
R_A	5K-10K	5K-10K	5K-10K
R_B	5K-10K	5K-10K	5K-10K
R_{AI}	10K	10K	10K

Component address table (external constant current IC)

	24V	12V	5V
R1	2.4K	2.4K	2.4K
R_{V1}	1.2K	500	None
D1	5V	5V	None

Note 1: When powered by 5V, R1 can be directly pulled up to the 5V power supply

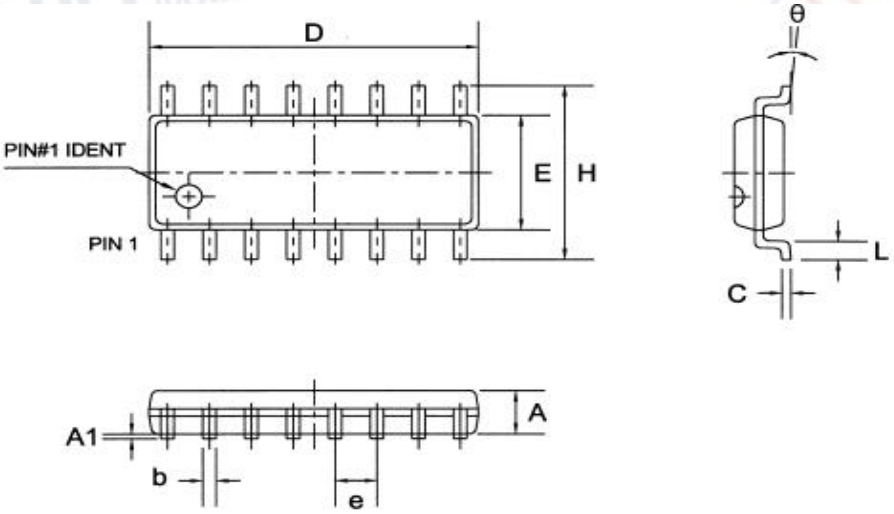
Component address table (0-field prototype application)

	24V	12V	5V
R_V	600-700	600-700	100
D_2	5V	5V	None

Note: In order to be compatible with 12V/24V, R_V should use a 1W resistor or multiple resistors in series and parallel to share the power, and D_2 should use a voltage regulator tube above 1/4W

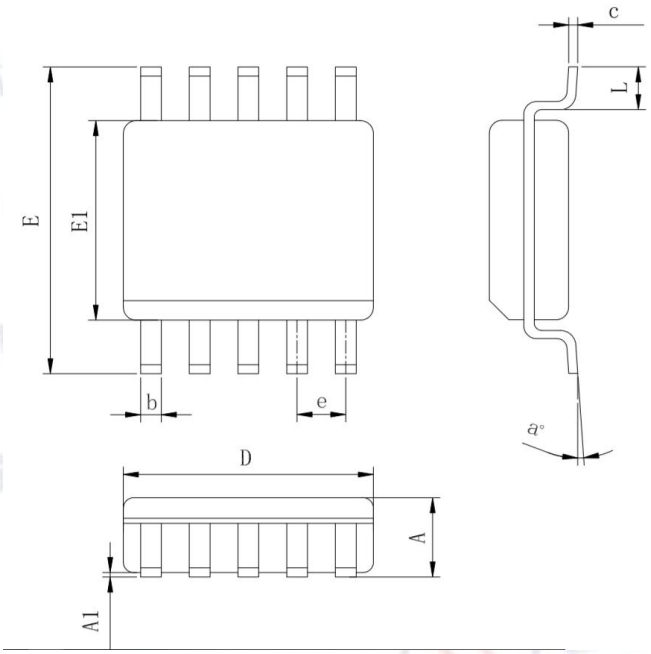
Package Outline and Dimensions

SOP16



Symbol	Dimensions In Millmeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	1.30	1.50	1.70	0.051	0.059	0.067
A1	0.06	0.16	0.26	0.002	0.006	0.010
b	0.30	0.40	0.55	0.012	0.016	0.022
C	0.15	0.25	0.35	0.006	0.010	0.014
D	9.70	10.00	10.30	0.382	0.394	0.406
E	3.75	3.95	4.15	0.148	0.156	0.163
e	—	1.27	—	—	0.050	—
H	5.70	6.00	6.30	0.224	0.236	0.248
L	0.45	0.65	0.85	0.018	0.026	0.033
θ	0°	—	8°	0°	—	8°

SOP10



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.75
A1	0.10	--	0.23
b	0.30	--	0.40
c	0.19	--	0.25
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.00 BSC		
L	0.40	--	0.80
a°	0°	--	8°

Version	Date of release	Description
VER1.0	2021-1-15	Initial release
VER1.1	2021-11-01	Content revised
VER1.2	2021-12-06	Content revised
VER1.3	2022-5-26	Content revised
VER1.5	2022-6-13	Content revised