Intelligent defective pixel resumable data transfer series: 3-channel 65536-level grayscale LED Driver IC UCS8603

Product Overview

UCS8603 is a special circuit for LED driver control of 3-channel 65536-level grayscale function of intelligent defective pixel resumable data transfer series, with internal circuits such as MCU digital interface, data latch and LED high voltage driver. The single brightness of the chip is controlled by peripheral MCU, and the cascaded control is used to realize the color lattice luminescence control of the outdoor large screen. Intelligent defective pixel resumable data transfer series IC adopts advanced HPD intelligent error signal recognition technology so that the channel error signal recognition rate is more than 99%, and it also adopts the patented dual-decoding engine to monitor 2 channels at the same time. Real-time switching can be realized if there is any channel signal problem. The RGB channel output of UCS8603 adopted is 65535-level grayscale output, with the function of independent adjustment of the current of each channel, high-precision constant current design, and 8K port refreshing frequency, which makes the picture effect more reproducible to the real colours, rich and gorgeous. The product has excellent performance and is stable and reliable.

Functional Features

- For dual-channel defective pixel resumable data transfer function, the fault point signal can continue to be transferred downward so that the overall fault resumable data transfer rate is 99% or more, and the picture is not misplaced
- Advanced HPD intelligent error signal recognition technology makes the channel fault recognition rate reach over 99%
- The patented Dual Decode Engine monitors and decodes two channels simultaneously. If there is a problem with any of the channels in use, it will be switched to the normal channel in real time. Due to real-time switching, it is also more difficult to detect the abnormal process of the screen by human eyes in case of any malfunction
- It can work properly at any frame rate
- Advanced channel fault test function:
  1. Real-time response function during channel testing: Dynamic detection of any channel fault is conducted in real time through the test programme. When the main channel is normal, the red light is ON, and when the auxiliary channel is normal, the green light is ON.When any channel is faulty, the corresponding light is OFF, and when the fault is restored, the light is ON, with real-time monitoring and real-time response.This real-time response functions facilitates the identification of soft faults that occur more frequently.
  2. Dual channel short circuit test function: When the 2 channels of IC are short-circuited, although the pattern procedure is normal in the production test, it is easy to cause instability under the environment of various large disturbances in the project. With the dedicated test programme of defective pixel resumable data transfer series, such faults are effectively identified by the light status of the light that is OFF.

- 65536/4096/256-levels grayscales are optional; port refresh frequency: 8K
- High constant current accuracy design
- Each channel of RGB current can be set independently by software and divided into 16-level. 1.5mA-24mA, polarity difference 1.5mA
- Data transmission frequency: 800K/S and1.6M/S (optional)

- With built-in 5V voltage regulator in VDD of the chip, the withstand voltage of output port is 28V
- Power on, RGB channels are closed, black

- Designed with low-voltage enhancement technology to significantly reduce interference caused by power fluctuations. UCS8603 (800K/S) can operate above 2.5V, and UCS8603 (1.6M/S) can operate above 3.5V
- Patented S-AI anti-interference technology significantly reduces and filters out radiated and conducted interference
- S-Drive drive technology and enhanced receiving technology greatly enhance the distance between points of connection
- Industrial grade design, stable and reliable

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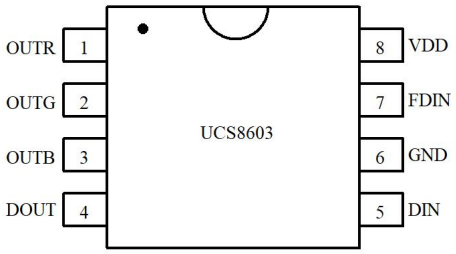
Pin map UCS8603 SOP8（6*5） UCS8603AD DFN8（2*2）



Pin description

	UCS8603/UCS8603AD	
S.N	Symbol	Function description
1	OUTR	Red - PWM control output
2	OUTG	Green - PWM control output
3	OUTB	Blue - PWM control output
4	DOUT	Display data cascade output
5	DIN	Display data input
6	GND	Grounded
7	FDIN	Auxiliary display data input
8	VDD	Power supply

Limit parameters (Note 1) (T_A = 25℃, V_{SS} = 0V if not otherwise specified)

Parameter	Symbol	Scope	Unit
Logic supply voltage	V_{dd}	6	V
Logic input voltage	V_i	−0.5～V_{dd}+0.5	V
OUTR/G/B output port withstand voltage	V_{out}	30	V
Max. clamp current of VDD port	I_{damp}	25	mA
Thermal resistance of PN junction to ambient (Note 2)	$R\theta JA$	120	℃/W
Power consumption (Note 3)	P_d	600	mW
Operating junction temperature	T_j	−45～+160	℃
Storage temperature	T_{stg}	−55～+150	℃

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Human body discharge mode (HBM)	ESD	4000	V

Note 1: Limit parameter means that beyond this operating range may damage the chip. When operating within the limits of the parameters, the device functions correctly, but the compliance with the individual performance specification cannot be completely guaranteed.

Note 2: RθJA is measured on a single-layer thermal conductivity test plate under natural convection at T_A=25° C in accordance with thermal measurement standard (JEDEC JESD51).

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

Recommended operating scope (Ta = -40 ~ +85°C, Vss = 0V if not otherwise specified)

Parameter	Symbol	Min.	Typical	Max.	Unit	Test conditions
Logic supply voltage	V_{dd}	3	5	5.7	V	-

Electrical parameters (Ta = -40 ~ +85°C, Vss = 0V, Vdd = 4.5 ~ 5.5V if not otherwise specified)

Parameter	Symbol	Min.	Typical	Max.	Unit	Test conditions
Clamp voltage	V_{dd}	4.8		5.5	V	V_{in}=12V, voltage dropping resistor 1K
Dynamic current loss	I_{DDdyn}		2		mA	RGBW OFF/DO OFF
OUTR/G/B output current	I_{out}	1.5	18	24	mA	Software settings
Low level output current	I_{pol}	-	25	-	mA	V_{po} = 0.4V
High level output current	I_{poh}	-	17	-	mA	V_{po} = 4.6V
High level input current	V_{ih}	0.7 V_{dd}	-		V	D_{IN} high level
Low level input current	V_{il}	-	-	0.3Vdd	V	D_{IN} low level
Hysteresis voltage	V_h	-	0.35	-	V	D_{IN}
OUTR/G/B constant current knee point voltage	V_{DS_1}		0.6		V	I_{out}=24mA
Current offset	dI_{out}			±5	%	V_{ds}=2V
Current offset	%dVds		±0.5		%/V	I_{out}=18mA, 1V<Vds<3V
	%dVdd		±0.5		%/V	I_{out}=18mA, 4.5V<Vdd<5.5V
	%dT_A		±3.0		%/℃	I_{out}=18mA, T_A =-40~+85℃

Switching features (T_a = -40 ~ +85°C, V_{ss} = 0V, V_{dd} = 4.5 ~ 5.5V if not otherwise specified)

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Parameter	Symbol	Min.	Typical	Max.	Unit	Test conditions
PWM frequency at OUT port	F_{pwm1}	-	8	-	KHz	I_{OUT} = 18mA, OUT is in series with 10Ω resistor to 5V
Data transmission frequency	F_{d1}		800		KHz	
	F_{d2}		1600		KHz	
Transmission delay time	T_{d1}	-	200	-	ns	C_l= 15pF, D_{in} → D_{out}
Input capacitance	C_i	-	15	-	Pf	

Description of power-on status

RGB channels are black after power-on

Defective pixel resumable data transfer function

1. UCS8603 adopts defective pixel resumable data transfer function for dual channel input. When there is a fault point, the signal can skip the fault point and continue the transmission.
In the case of a faulty point being skipped and the transmission is continued, the next level of IC will automatically recognize the source of the signal and correct the data accordingly, so the screen will not be misaligned.

2. UCS8603 adopts advanced HPD intelligent error signal recognition technology to make the channel fault recognition rate reach over 99%. Accurate channel switching is only possible if channel faults are effectively recognized. If the fault phenomenon that can be identified is limited, thus some channel faults cannot be identified during occurrence and cannot be switched to a valid channel, or will be switched to a faulty channel due to misjudgement of the valid channel, all of these will reduce the reliability of defective pixel resumable data transfer function, or even the failure rate is greater than the single-channel transmission.HPD intelligent error signal recognition technology can effectively identify a variety of faults caused by the signal changes, and it is identified by means of real-time comparison through the 2 channels, which can maximize the identification of channel faults in order to maximize the possibility of producing the effect of defective pixel resumable data transfer.

3. UCS8603 adopts the patented dual decoding engine technology, which can achieve simultaneous monitoring and comparison of decoded data from 2 channels. Both channels are decoded in real time.
The decoding data of each channel is judged by HPD technology. Then, the judgment results of the two channels are compared and verified to decide whether to switch channels.Basically, this avoids unnecessary or even potentially erroneous switching and reduces the resulting failure rate.

4. UCS8603 can be used without frame rate limitation and will not cause false switching even if the frame rate is even lower.

5. UCS8603 monitors and compares the 2 channels in real time. Once a channel fails, the UCS8603 recognizes and switches channels in real time.
Due to real-time switching, it is also more difficult to detect the abnormal process of the screen by human eyes in case of any malfunction. That is to say, even if the channel used by any lamp in the working process fails, the human eye cannot observe the abnormal image in many times.

6. UCS8603 fault recognition rate is derived from tests conducted in our laboratory by simulating various hard and soft faults.
In addition to simple hard fault simulation tests, our laboratory will simulate and test the following soft faults:

Short circuit fault: For each simulated fault, the full range of short circuit resistance values from micro short circuit (short circuit resistance: 5K) to full short circuit (short circuit resistance: 0Ω) are tested

Open circuit fault: For each simulated fault, the full range of open circuit resistance values from micro-open circuit (short circuit resistance: 1Ω) to full open circuit (open circuit resistance: 100M) are tested

High and low frequency faults: For each simulated fault, the full frequency range from 1HZ to 1M is tested

Note: According to the application scheme provided by us, the overall fault resumable data transfer rate is >99%

Test Description

During production testing, it is recommended to test in the following 2 steps:

1. General test: The controller sends R-G-B-black four-colour jump program or other programs that can measure the normal operation and effectively detect the missing colour and light leakage phenomenon.
In addition to testing for light faults, it also lays the groundwork for the next channel test.

2. Single channel fault and 2-channel short circuit test: Single channel fault or 2-channel short circuit fault can be effectively and dynamically identified in real time by using channel test program test, as shown in the table below:
The brightness of 25% when the light is ON

a. Only the main channel is normal: R is ON, GB remain in the original state (black)
b. Only the auxiliary channel is normal: G is ON, RB remain in the original state (black)
c. The main and auxiliary channels are normal: RG are ON, B remains in the original state (black)
d. The main and auxiliary channels are abnormal: RGB remain in the original state (black)

e. Short-circuit of the main and auxiliary channels: RGB remain in the original state (black)

Note 1: When the test in step 2 is carried out, the test controller should first send 3 frames of all-black picture (the RGB are all-black) when entering the test, and
then send the special test program. Only in this way can we observe the correct lighting state, which means "Original State (black)".

Note 2: The UCS8603 has real-time response capability during step 2 test: For example, when the main channel is normal, the red light is ON.
Without power failure, the red light is OFF if the main channel fails again. When the fault is cleared, the red light is ON immediately.
This dynamically detects any channel fault in real time through the test programme, which is also applicable to the auxiliary channels. This means that channel tests and responses are conducted in real time. This makes it easier to identify problems during commissioning and production testing, and also facilitates maintenance.

Note 3: The step 2 test adopts the L-P algorithm to identify soft faults that occur at higher frequencies.
Generally, hard faults are easy to be observed, but soft faults (which are not continuously present) are not easily recognized.
UCS8603 adopts the L-P algorithm to identify soft faults that occur at higher frequency, which are marked by a bright flashing light.

Note: If a UCS8603-compatible test controller has both DO and FDO ports, the DO and FDO ports can be connected to the DIN and FDIN terminals of the first light, respectively.
If the test controller has only has DO port but does not have FDO port, do not connect the DO port to both DIN and FDIN of the first light.
Otherwise, the first light will not be ON normally during the test mode, and the controller DO port can only be connected to the DIN of the first light.

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Instructions for pulling wire over a long distance

UCS8603 adopts S-Drive technology so that it has strong wire pulling capability. Length of wire pulled for inter-point is up to 10m or more at 800K/S; Length of wire pulled for inter-point is more than 2m at 1.6M/S; and there is no limit to the number of points that can be used to pull the long wire. To obtain a longer length of stay wire between points, the following should be observed:

1. Please design exactly according to the peripheral parameters required by this manual. A capacitor is required between VCC and GND, as shown in the application diagram.

2. When pulling long wires, the voltage at the sending point (the point where the output is connected to the long wire) should not be too low, e.g., not less than 21V for 24V-powered lights, and not less than 10V for

12V-powered lights.

3. For long wire, the wire with copper conductor with a diameter of 0.3mm can be used, but aluminium wire, iron wire or copper-clad aluminium wire cannot be used

Settings of constant current value for each colour

1. UCS8603 can independently set the constant current values for the R, G and B channels. Constant current value can be set to 16-level per channel. Scope of figures: 1.5mA-24mA; Polarity difference: 1.5mA

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The following table gives the constant current values for each of the 16-level.

R/G/B	Constant current value (mA)
1	1.5
2	3
3	4.5
4	6
5	7.5
6	9
7	10.5
8	12
9	13.5
10	15
11	16.5
12	18
13	19.5
14	21
15	22.5
16	24

2. Through the independent setting function of RGB channel constant current value, different current ratios can be carried out on RGB lamp beads to achieve the actual white balance effect.

Combined with the high grayscale of 65536/4096-level, this can achieve high-quality picture effect.

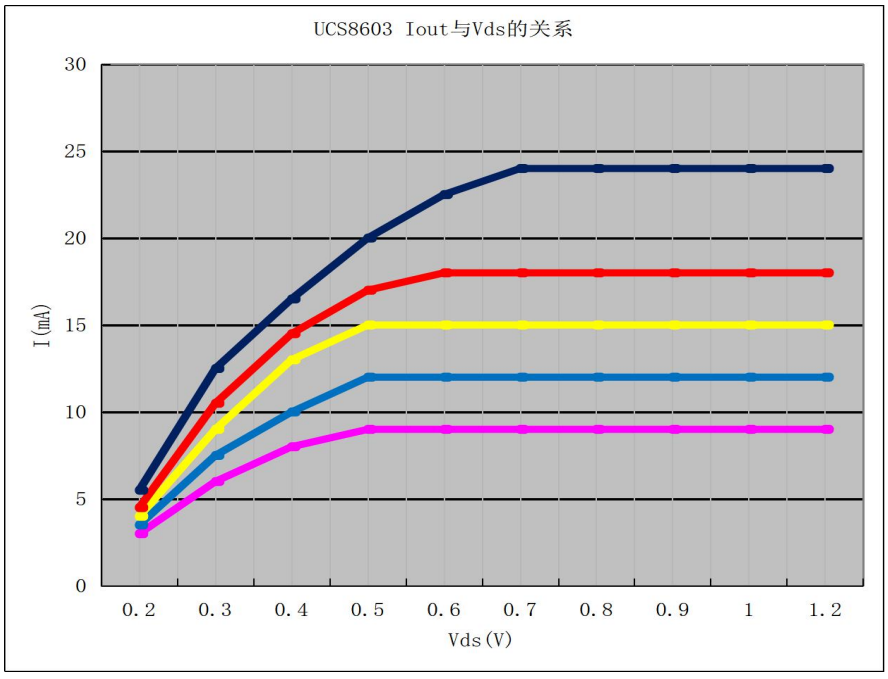
3. Through the constant current value setting function, different currents (power or brightness) can be set through software according to the actual needs of lamps.

Constant Current Curve

UCS8603 has excellent constant-current characteristics, with minimal current differences between channels and even between chips.

(1): UCS8603 output current is not affected when the voltage at the load terminal changes, as shown in the figure below

(2): According to the relationship between the current Iout and the voltage Vds applied to the output port of the UCS8603 in the figure below, the smaller theIout current is, the smaller Vds is required in the constant current state.



Application Line Diagram

1.5V power supply, stringed with single LED

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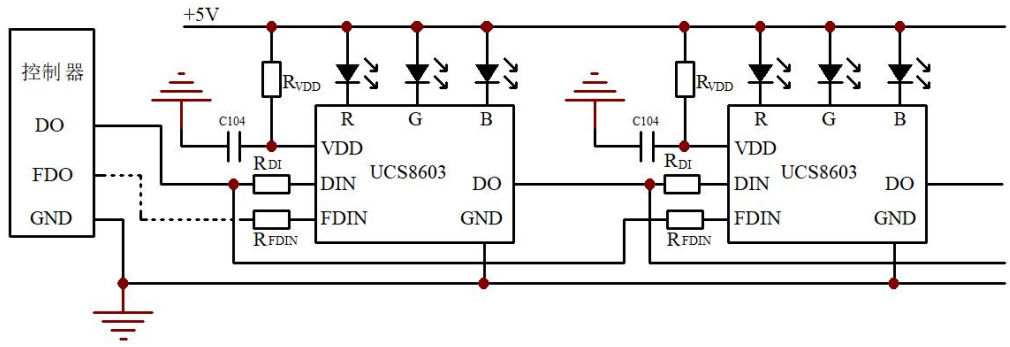

Note 1: In the application, the connection from the controller FDO to the UCS8603 can be left unconnected. At this point, the first point does not have full breakpoint resumable data transfer function.

Note 2: For 5V application, one protection resistor RDI and one protection resistor RFDI should be connected in series at DIN terminal and FDIN terminal respectively (see the component value table attached for resistance)

In case of board space limitation, the resistor RFDIN on the FDIN side can be omitted, but the protection resistor RDI on the DIN side cannot be omitted

Note 3: Please be noted that the FDIN of the next IC should be wired from the other end of the (RDI resistor connected to the DIN pin), rather than directly from the DIN pin to the FDIN of the next IC

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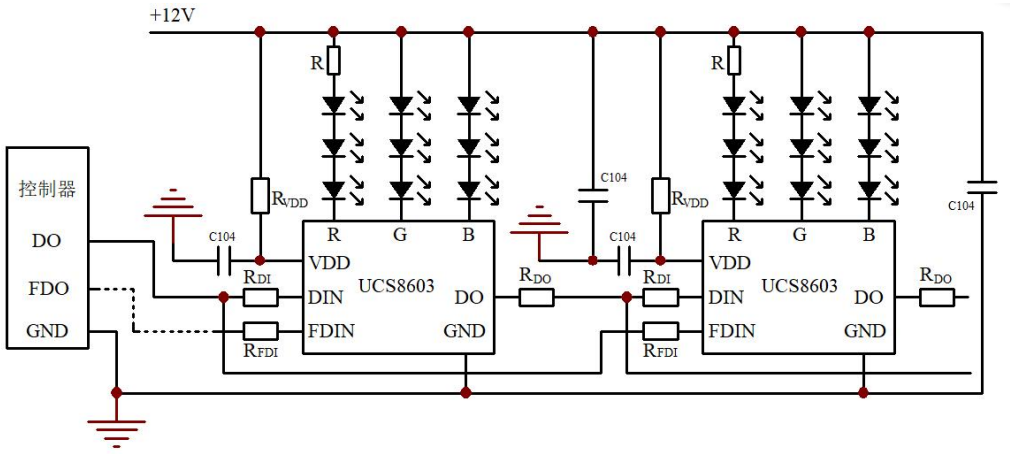
2. 12V power supply, stringed with 3 LEDs



Note 1: In the application, the connection from the controller FDO to the UCS8603 can be left unconnected. At this point, the first point does not have full breakpoint resumable data transfer function.

Note 2: For 12V application, a protection resistor must be connected to each of the DIN, FDIN and DO ports as shown in the figure (see the component value table attached for resistance)

Note 3: Please be noted that the RFDI of the next IC should be wired from the other end of the (RDI resistor connected to the DIN pin), rather than directly from the DIN pin to the RFDI of the next IC

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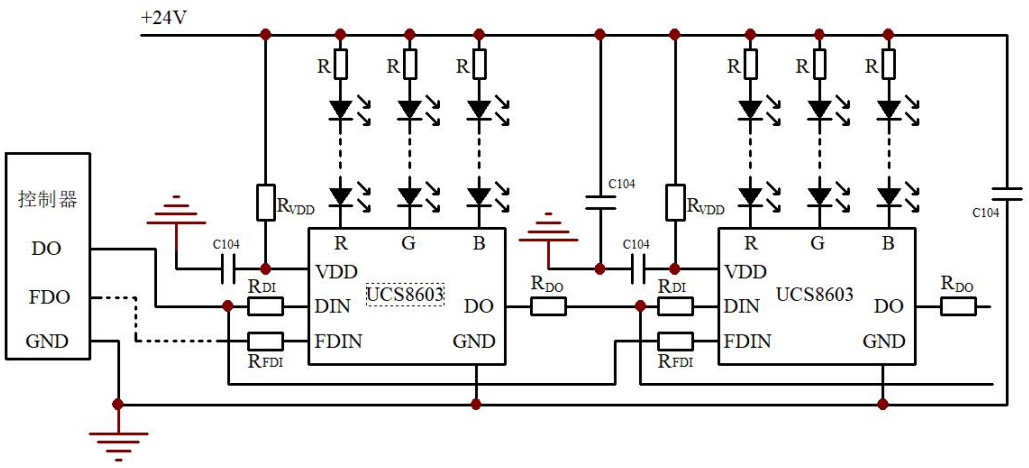
3. 24V power supply, stringed with 4-6 LEDs



Note 1: In the application, the connection from the controller FDO to the UCS8603 can be left unconnected. At this point, the first point does not have full breakpoint resumable data transfer function.

Note 2: For 24V applications, a protection resistor must be connected to each of the DIN, FDIN and DO ports as shown in the figure (see the component value table attached for resistance)

Note 3: Please be noted that the protection resistor RFDI of the next IC should be wired from the other end of the (RDI resistor connected to the DIN pin), rather than directly from the DIN pin to the protection resistor RFDI of the next IC

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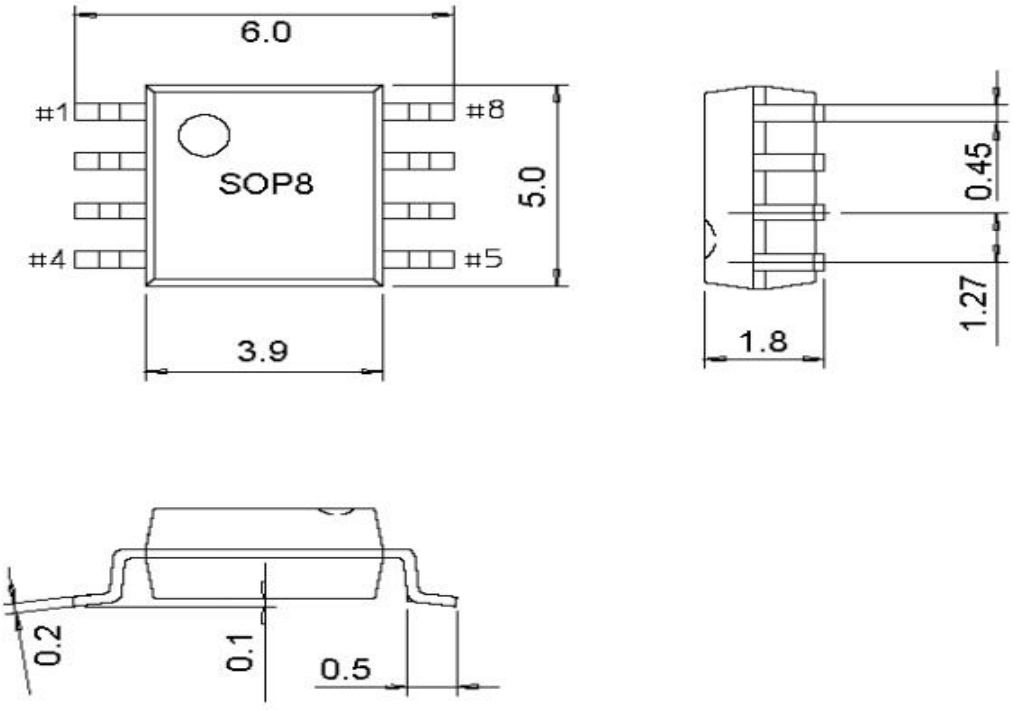
Component value table: To better realize the breakpoint resumable data transfer function, it is recommended that customers shall select the values according to the following table

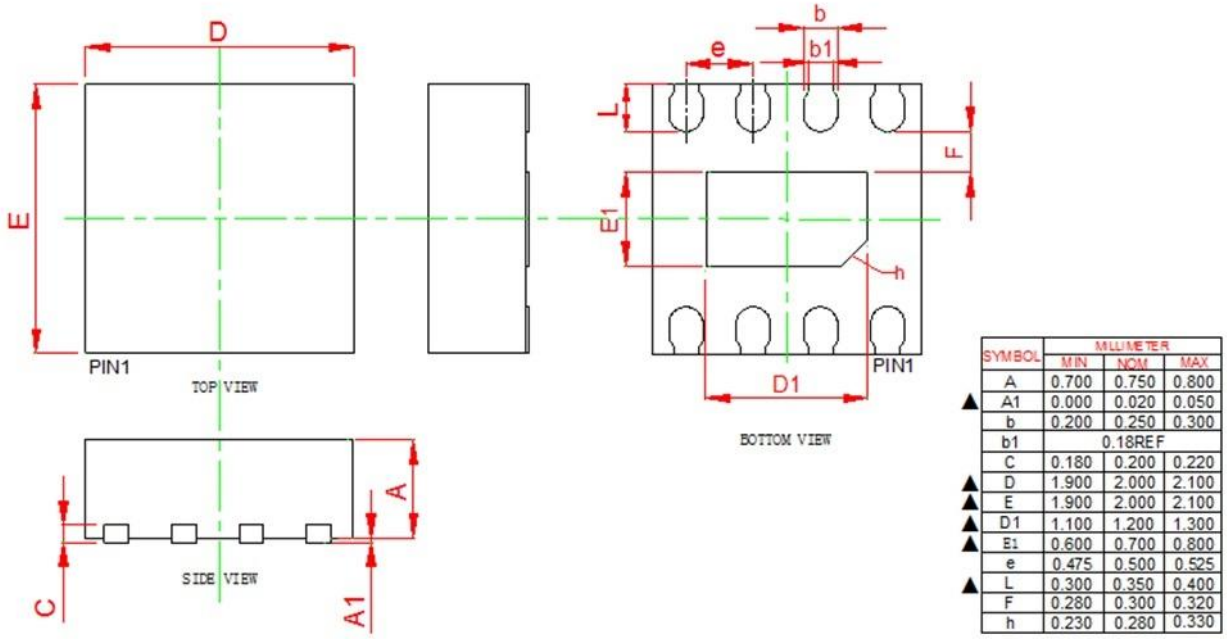
Components	24V	12V	5V
RVDD	2.2K (1206 package)	750	100
RDI	500	500	500
RFDI	500	500	500
RDO	120	120	

Package Outline Drawing and Dimensions

SOP8



DFN8



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.700	0.750	0.800
▲ A1	0.000	0.020	0.050
b	0.200	0.250	0.300
b1		0.18REF	
C	0.180	0.200	0.220
▲ D	1.900	2.000	2.100
▲ E	1.900	2.000	2.100
▲ D1	1.100	1.200	1.300
▲ E1	0.600	0.700	0.800
e	0.475	0.500	0.525
▲ L	0.300	0.350	0.400
F	0.280	0.300	0.320
h	0.230	0.280	0.330

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