1.Description

ULN2001D is a single-chip integrated high voltage, high current Darlington transistor array, which contains three independent Darlington transistor drive channels inside the circuit. The circuit is internally designed with a freewheeling diode, which can be used to drive inductive loads such as relay stepper motors. A single Darlington tube collector can output a current of 500mA, and connecting multiple channels in parallel can achieve higher current output capabilities. This circuit can be widely used in relay drive, lighting drive, display screen drive (LED), stepper motor drive, and logic buffer.

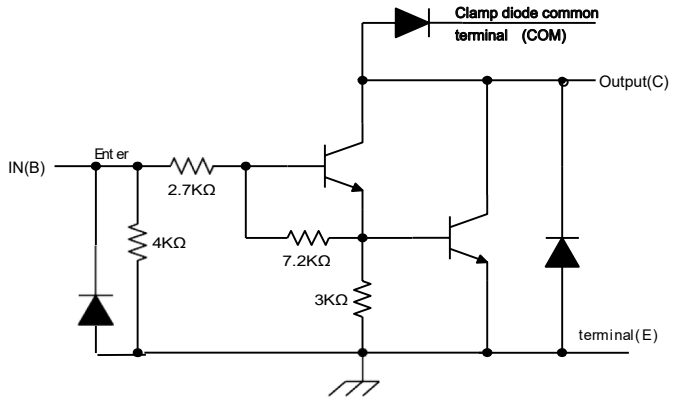
2.Features

- 500mA collector output current (single circuit)
- High voltage resistance (50V)
- Input compatible TTL/CMOS logic signal
- Widely used in relay drive
- ULN2001D input port integrates 4K pull-down resistance to ground

3.Applications

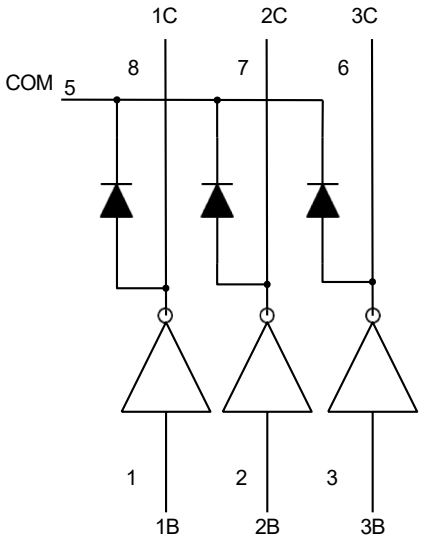
- Relay drive
- Indicator light driver
- Display screen driver

4.Circuit Schematic (Single Darlington Driver Circuit)



Schematic diagram of ULN2001D single circuit Darlington drive circuit

5.Logic Diagram



Pin Descriptions

Pin Number	Pin Names	Input/Output	Description
1	1B	I	1-channel input pin
2	2B	I	2-channel input pin
3	3B	I	3-channel input pin
4	E	-	Grounding
5	COM	-	Clamp diode common
6	3C	O	3-channel output pin
7	2C	O	2-channel output pin
8	1C	O	1-channel output pin

6.Absolute Maximum Rating (T_A=25°C, unless otherwise specified)

Parameter		Symbol	value	Units
Collector emitter voltage (6-8 pins)		V_{CE}	50	V
COM terminal voltage (5 pins)		V_{COM}	50	V
Input voltage (1-3 pins)		V_I	30	V
Single collector peak current		I_{CP}	500	mA
Output clamp diode forward peak current		I_{OK}	500	mA
Maximum peak current of the total emitter		I_{ET}	-1.5	A
Packaging thermal impedance (1)(2)(3)	SOP8	θ_{JA}	160	°C/W
Maximum operating junction temperature		T_J	150	°C
Welding temperature			260	10s
Storage temperature range		T_{STG}	-65 to 150	°C

Note: 1. The maximum power consumption can be calculated according to the following relationship, $P_D=(T_J-T_A)/\theta_{JA}$

2. T_J represents the junction temperature at which the circuit operates, and T_A represents the ambient temperature at which the circuit operates

7.Recommended Operating Conditions

(T_A=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min	Max	Units
Output terminal voltage	$V_{CE(SUS)}$		0	50	V
Output current	I_{OUT}	Continuous output, T_A=85°C		100	mA/ch
Input Voltage	V_{IN}		0	12	V
Input voltage (output turned on)	$V_{IN(ON)}$	I_{OUT}=400mA	2.8	12	V
Input voltage (output shutdown)	$V_{IN(OFF)}$		0	0.7	V
Clamp diode reverse voltage	V_R			50	V
Clamp diode forward peak current	I_F			350	mA
Working temperature range	T_A		-40	85	°C
Working temperature	T_J		-40	125	°C
Dissipative power consumption	P_D	T_A=25°C		0.625	W
SOP8		T_A=85°C		0.25	W

Note: 1. T_A represents the ambient temperature at which the circuit operates

2. The calculation method for circuit power consumption is:

$P_D=V_{CE(ON)1}\times I_{C1}+ V_{CE(ON)2}\times I_{C2}+ V_{CE(ON)3}\times I_{C3} + V_{IN1}\times I_{IN1}+ V_{IN2}\times I_{IN2}+ V_{IN3}\times I_{IN3}$

3. Note 2 $V_{CE\ (ON)n}$ represents the conduction voltage drop of the corresponding channel, where n=1,2,3;

IC Represents the average load current of the corresponding channel, where n=1,2,3;

V_{INn}Represents the average high-level input signal of the corresponding channel, where n=1,2,3;

I_{INn}Represents the average input current of the corresponding channel's signal, where n=1,2,3;

8.Electrical Parameter Characteristic Table

(T_A=25°C, unless otherwise specified)

Parameter	Test Chart	Conditions			Min.	Typ.	Max.	Units
$V_{I(ON)}$Conduction state input voltage	Figure 2	V_{CE}=1.5V (Input unrestricted)	T_A=0°C	I_C=30mA		1.73	2.1	V
				I_C=60mA		1.76	2.1	
				I_C=120mA		1.8	2.2	
				I_C=240mA		1.88	2 3	
				I_C=350mA		2	2.4	
			T_A=25°C	I_C=30mA		1.63	2	
				I_C=60mA		1.66	2	
				I_C=120mA		1.69	2.1	
				I_C=240mA		1.76	2.2	
				I_C=350mA		1.87	2.3	
		I_I=800uA (V_{CE}<1.5V)	T_A=0°C	I_C=30mA		2.21	2.65	
				I_C=60mA		2.25	2.7	
				I_C=120mA		2.3	2.76	
				I_C=240mA		2.42	2.9	
				I_C=350mA		2.55	3.06	
			T_A=25°C	I_C=30mA		2.25	2.7	
				I_C=60mA		2.28	2.74	
				I_C=120mA		2.33	2.8	
				I_C=240mA		2.44	2.93	
				I_C=350mA		2.57	3.08	

Parameter	Test Chart	Conditions			Min.	Typ.	Max.	Units
$V_{I(ON)}$Conduction state input voltage	Figure 2	I_I=1mA (V_{CE}<1.5V)	T_A=0°C	I_C=30mA		2.54	3.05	V
				I_C=60mA		2.58	3.1	
				I_C=120mA		2.64	3.17	
				I_C=240mA		2.77	3.32	
				I_C=350mA		2.91	3.49	
			T_A=25°C	I_C=30mA		2.6	3.12	
				I_C=60mA		2.64	3.17	
				I_C=120mA		2.7	3.24	
				I_C=240mA		2.83	3.4	
				I_C=350mA		2.98	3.58	
$V_{CE(SAT)}$ Collector emitter saturation voltage drop	Figure 3	V_I=2.4V (I_I>800uA)	T_A=0°C	I_C=30mA		0.8		
				I_C=60mA		0.85		
				I_C=120mA		0.93		
				I_C=240mA		1.09		
				I_C=350mA		1.27		
			T_A=25°C	I_C=30mA		0.75		
				I_C=60mA		0.8		
				I_C=120mA		0.87		
				I_C=240mA		1.03		
				I_C=350mA		1.2		

Parameter	Symbol	Conditions			Min.	Typ.	Max.	Units
Input Current (Figure 2)	I_I	I_C=60mA	T_A=0°C	V_I=12V		6.6		mA
				V_I=6V		3.1		
				V_I=4.5V		2.04		
				V_I=2.4V		0.84		
			T_A=25°C	V_I=12V		6.3		
				V_I=6V		2.8		
				V_I=4.5V		1.97		
				V_I=2.4V		0.83		
Clamp diode forward voltage drop (Figure 5)	V_F	I_F=350mA	T_A=0°C			1.4	1.6	V
			T_A=25°C			1.4	1.6	
Collector turn off leakage current (Figure 1)	I_{CEX}	V_{CE}=50V, I_I=0					50	μA
Collector withstand voltage (Figure 1)	V_{CE}	V_{CE}=50V, I_I=0			50			V
Clamp diode reverse leakage current (Figure 4)	I_R	V_R=50V					50	μA
Low high transmission delay (Figure 6)	t_{PLH}	V_L=12V, R_L=45Ω				0.15	1	μs
Transmission delay high low (Figure 6)	t_{PHL}	V_L=12V, R_L=45Ω				0.15	1	μs

9.Electrical Parameter Testing Schematic Diagram

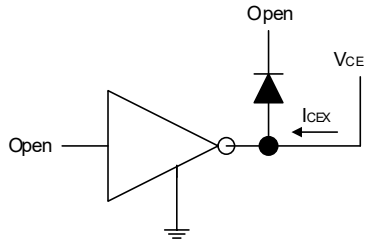


Figure 1. I_{CEX} Test Circuit

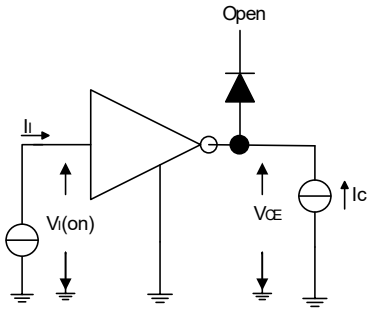


Figure 2. I_I and $V_{I(ON)}$ Test Circuit

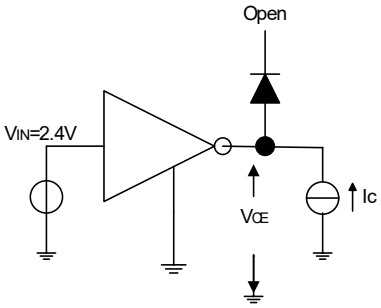


Figure 3. $V_{CE(sat)}$ Test Circuit

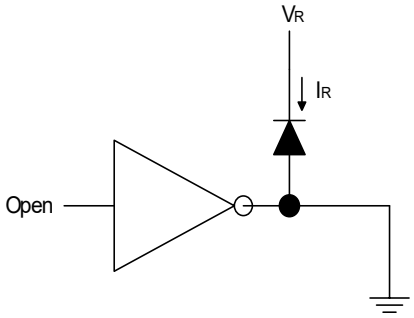


Figure 4. I_R Test Circuit

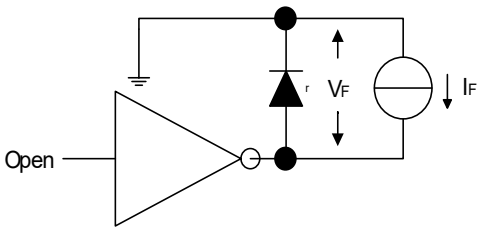


Figure 5. V_F Test Circuit

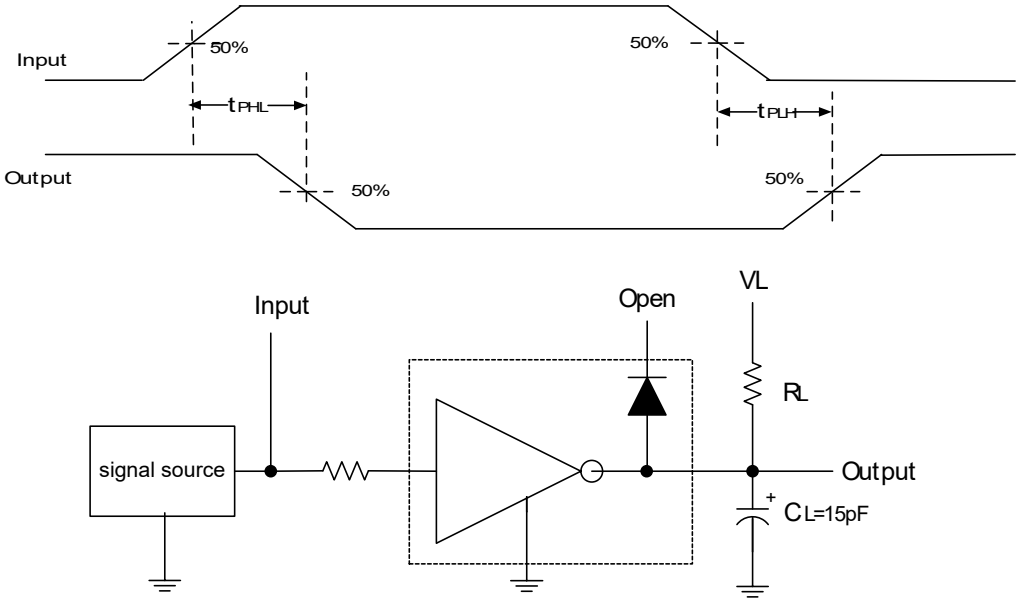


Figure 6. Transmission delay waveform

Note: The capacitive load in Figure 6 is the parasitic capacitance of the oscilloscope probe.

10.Typical Characterisitics

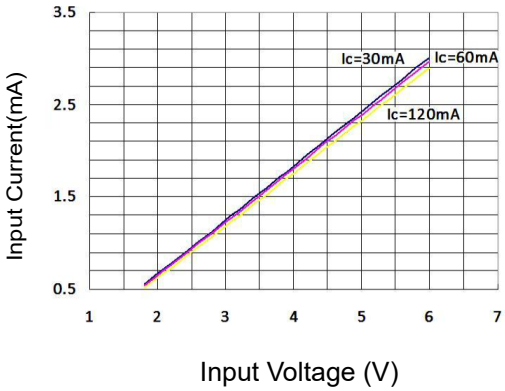


Figure 7: The relationship between input current and input voltage

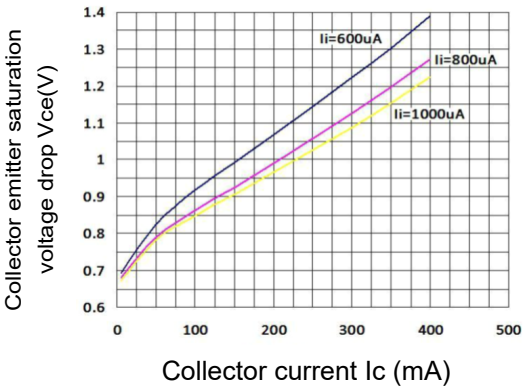


Figure 8: The relationship between collector emitter saturation voltage drop and collector current

11.Application Information

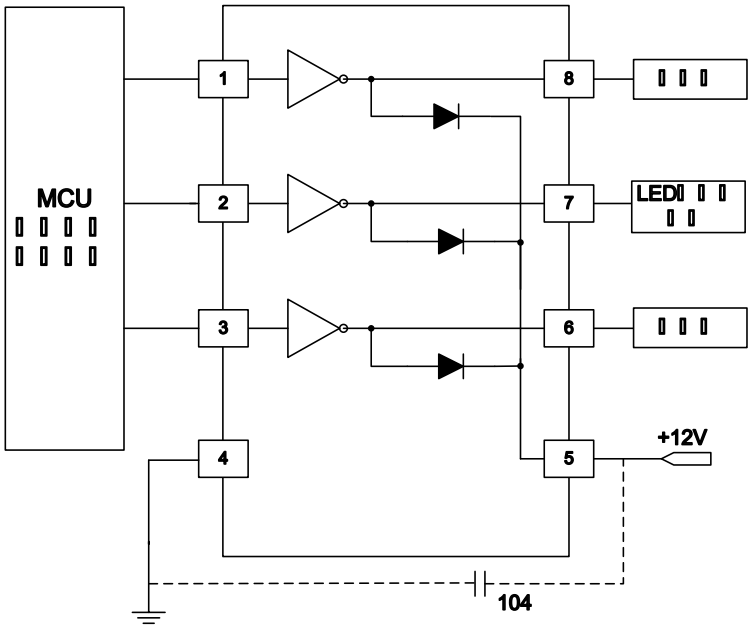


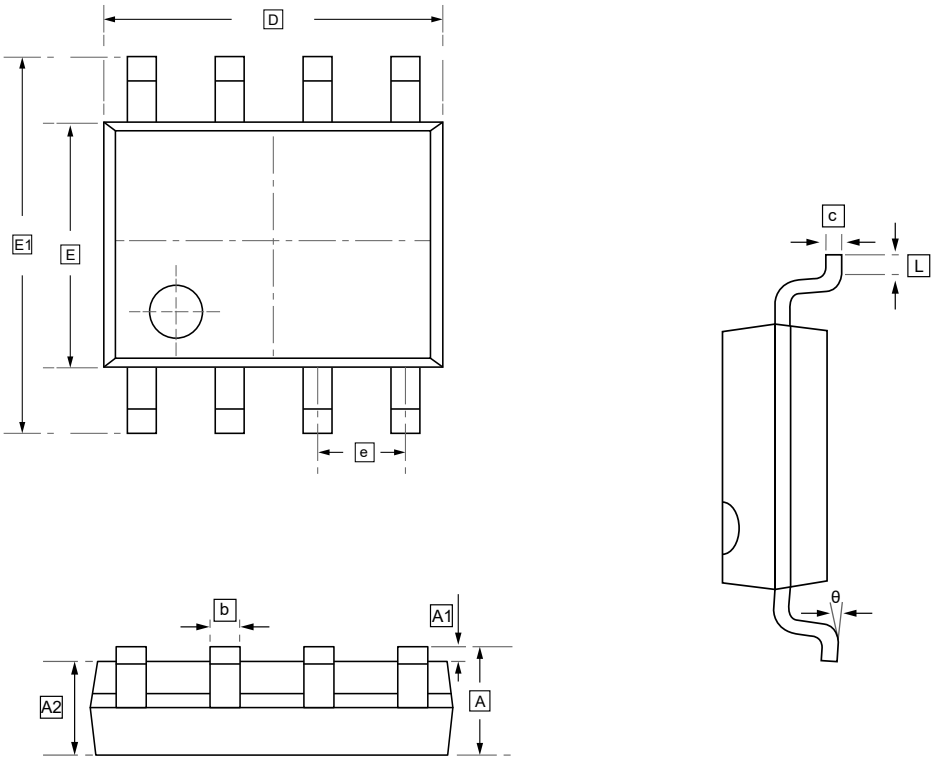
Figure 10. ULN2001D application circuit diagram

The application of ULN2001D is not limited to the application circuit diagram shown in Figure 10. In particular, the load of the drive circuit can be 3 relays, 3 LED, or 2 outputs can be used in parallel as 1 circuit. The specific application depends on the actual situation.

ULN2001D has built-in 4K pull-down resistance to ground, so no external pull-down resistance is required during use.

Special note: When the resistance capacitance step-down circuit is used to supply power to ULN2001D, because the resistance capacitance step-down voltage cannot prevent the transient high-voltage fluctuation on the grid, a 104 capacitor must be connected to the COM terminal and the ground terminal of ULN2001D, as shown in Figure 10. In other applications, this capacitor does not need to be added.

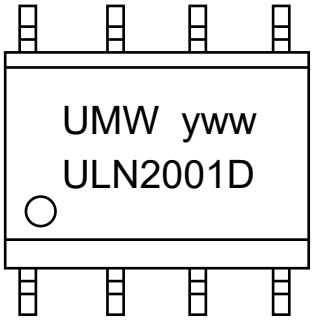
12.SOP-8 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	c	D	E	E1	e	L	θ
Min	1.350	0.000	1.350	0.330	0.170	4.700	3.800	5.800	1.270	0.400	0°
Max	1.750	0.100	1.550	0.510	0.250	5.100	4.000	6.200	BSC	1.270	8°

13.Ordering Information



yww: Batch Code

Order Code	Package	Base QTY	Delivery Mode
UMW ULN2001D	SOP-8	2500	Tape and reel

14.Disclaimer

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