A new three-channel relay driver circuit that

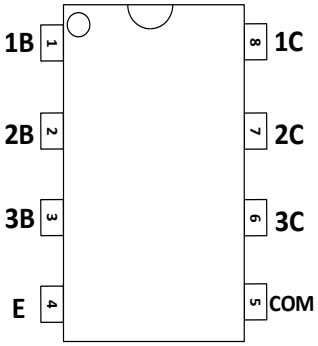
Description

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.

Each Darlington transistor of ULN2001D is connected in series with a 2.7K base resistor, which can be directly connected to TTL/CMOS circuits at a working voltage of 5V, and can directly process data that originally required standard logic buffers.

In addition, each Darlington transistor input stage of ULN2001D is designed with a 4K ground pull-down resistor to prevent load misoperation caused by the unstable state of the microcontroller.

Pin Arrangement



Characteristics

- 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

Typical applications

- Relay drive
- Indicator light driver
- Display screen driver

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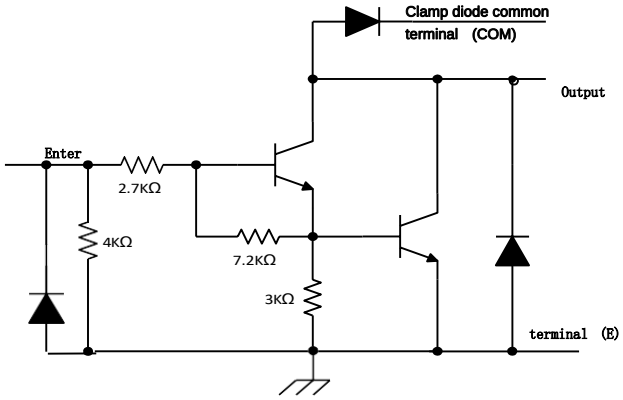
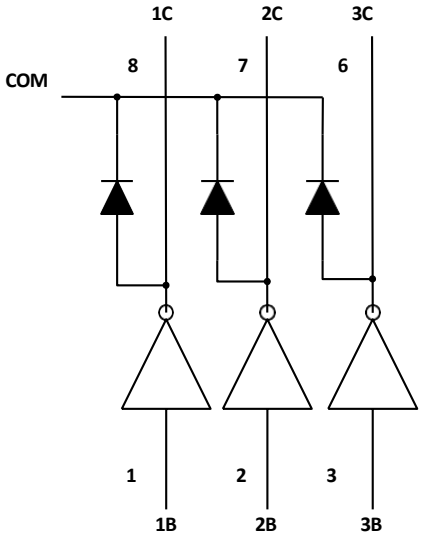
Circuit Schematic (Single Darlington Driver Circuit)



Schematic diagram of ULN2001D single circuit Darlington drive circuit

Logic diagram



Pin Definitions

pin number	pin names	Input/Output	Pin Function 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

Absolute maximum rating (TA=25 ˚C, unless otherwise specified)

parameters	Symbol	value	Unit
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	A
Packaging thermal impedance (1)(2)(3) SOP8	θ_{JA}	160	
Maximum operating junction temperature	T_J	150	
Welding temperature		260	,10s
Storage temperature range	T_{stg}	-65 to +150	

Note: 1. The maximum power consumption can be calculated according to the following relationship

$P_D=(T_J-T_A)/\theta_{JA}$;

2. TJ represents the junction temperature at which the circuit operates, and TA represents the ambient temperature at which the circuit operates

Recommended operating conditions (TA=25 ˚C, unless otherwise specified)

parameters	Symbol	Condition	Mini	Max	Unit
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)	$V_{IN(ON)}$	=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 SOP8	P_D	T_A= +25 ˚C		0.625	W
		T_A= +85 ˚C		0.25	

Note: 1. TA 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 VCE (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;

Electrical parameter characteristic table (TA=25 ˚C, unless otherwise specified)

parameters	Test chart	Test conditions			Mini	Typical	Max	Unit
$V_{I(ON)}$Conduction state input voltage	Figure 2	V_{CE}=1.5V (Input unrestricted)	T_A=0	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℃	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	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	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	
		I_I=1mA (V_{CE}<1.5V)	T_A=0	I_C=30mA		2.54	3.05	
				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	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	I_C=30mA		0.8		V
				I_C=60mA		0.85		
				I_C=120mA		0.93		
				I_C=240mA		1.09		
				I_C=350mA		1.27		
			T_A=25	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		

Electrical Parameter Characteristics Table Continued

(TA=25 ˚C, unless otherwise specified)

parameters	Test chart	Test conditions			Mini	Typical	Max	Unit
I_I Input Current	Figure 2	I_C=60mA	T_A=0℃	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℃	V_I=12V		6.3		
				V_I=6V		2.8		
				V_I=4.5V		1.97		
				V_I=2.4V		0.83		
V_F Clamp diode forward voltage drop	Figure 5	I_F=350mA	T_A=0℃			1.4	1.6	V
			T_A=25℃			1.4	1.6	
I_{CEX} Collector turn off leakage current	Figure 1	V_{CE}=50V I_I=0				--	50	μA
V_{CE} Collector withstand voltage	Figure 1	V_{CE}=50V I_I=0			50			V
I_R Clamp diode reverse withstand voltage	Figure 4	V_R=50V			50			V
I_R Clamp diode reverse leakage current	Figure 4	V_R=50V				--	50	μA
t_{PLH} Low high transmission delay	Figure 6	VL=12V RL=45Ω				0.15	1	μs
t_{PHL} Transmission delay high low	Figure 6	VL=12V RL=45Ω				0.15	1	μs

Electrical parameter testing schematic diagram

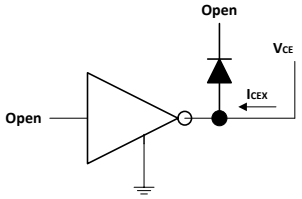


Figure 1 I_{CEX} Test Circuit

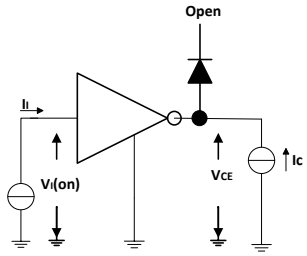


Figure 2 I_I and $V_{I(ON)}$ Test Circuit

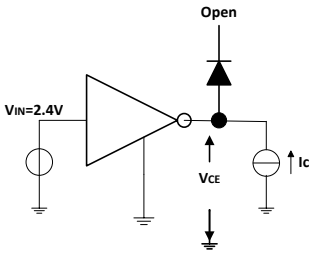


Figure 3 $V_{CE(sat)}$ Test Circuit

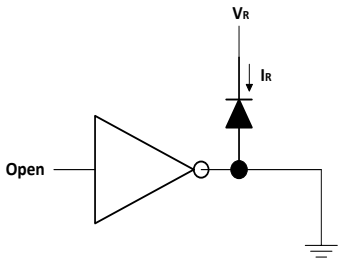


Figure 4 I_R Test Circuit

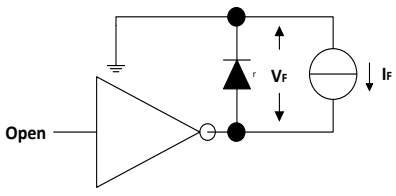


Figure 5 V_F Test Circuit

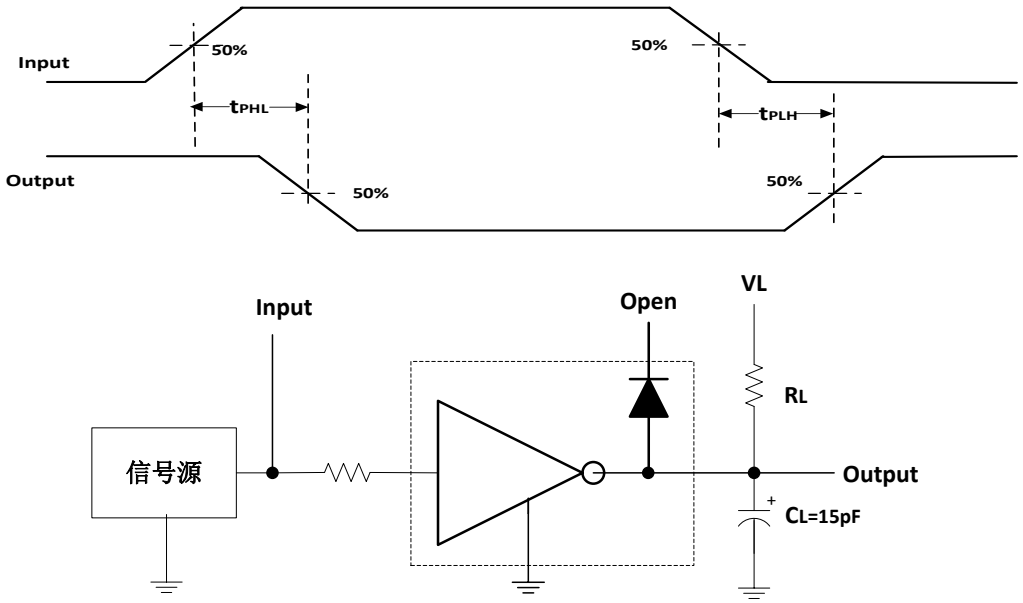
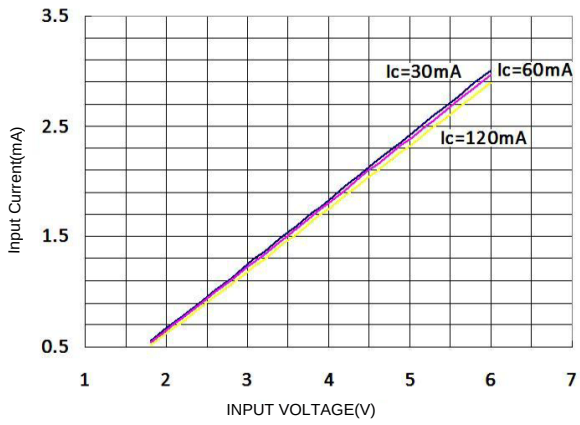


Fig. 6 Transmission delay waveform

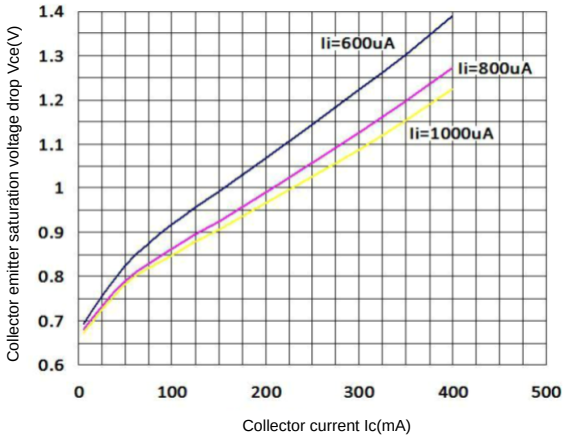
Note: The capacitive load in Figure 6 is the parasitic capacitance of the oscilloscope probe

Typical characteristic curves

The relationship between input current and input voltage



The relationship between collector emitter saturation voltage drop and collector current



Application Information

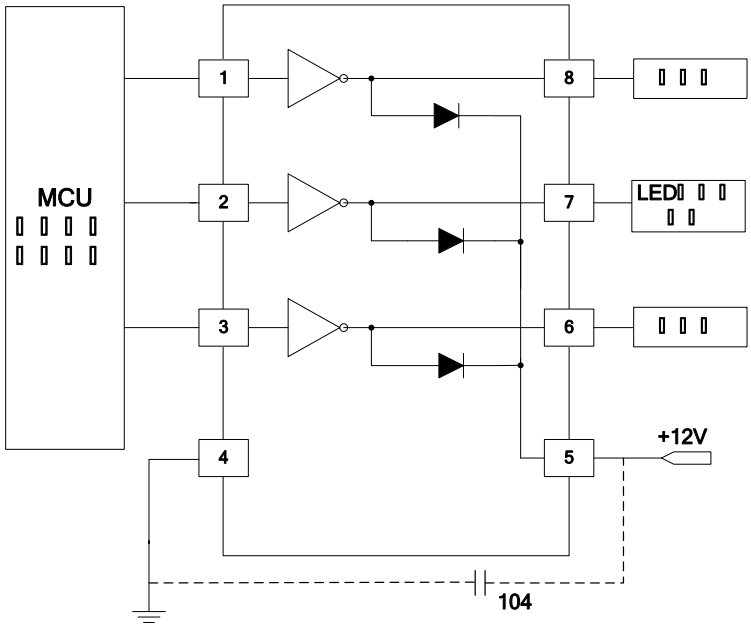


Figure 10 ULN2001D application circuit diagram

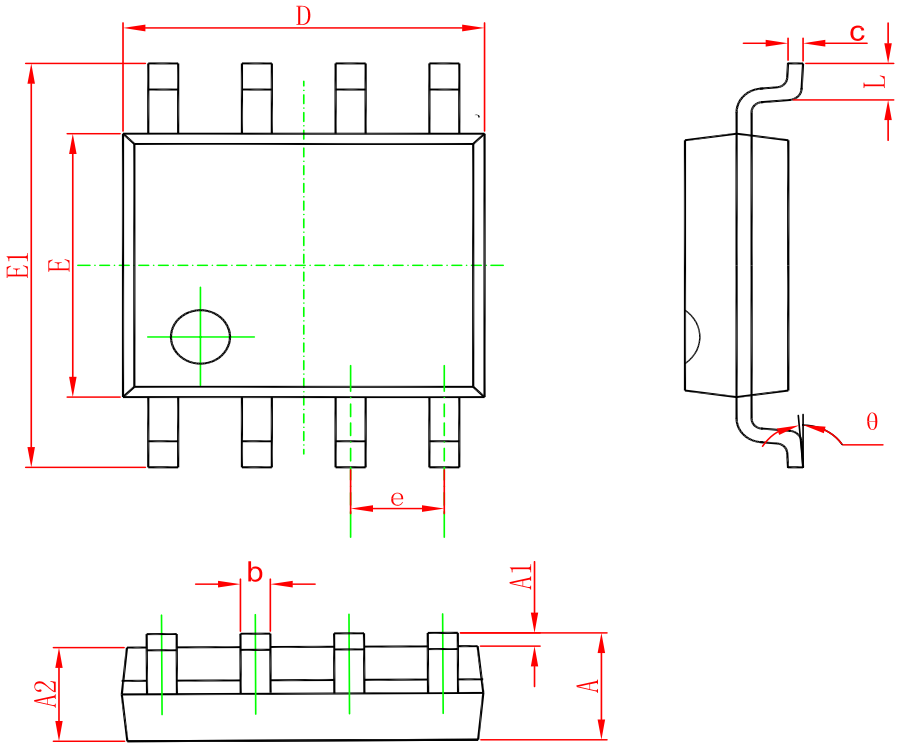
The application of ULN2001D is not limited to the application circuit diagram shown in Figure 10. In particular, the load of the drive circuit can be 3 relays, 3 LED, or 2 outputs can be used in parallel as 1 circuit. The specific application depends on the actual situation.

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.

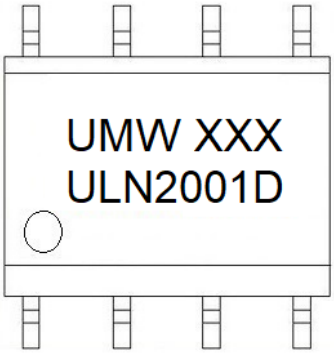
Package Dimension

SOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Marking



Ordering information

Order code	Package	Baseqty	Deliverymode
UMW ULN2001D	SOP-8	2500	Tape and reel