UMW ULN2002D

A new three-channel relay driver circuit that

1.Description

ULN2002D is a monolithic integrated high voltage withstand, high current Darlington array IC, with five independent Darlington drive channels inside the circuit. A freewheeling diode is designed inside the circuit, which can be used to drive inductive loads such as relays and stepping motors. Single Darlington

The tube collector can output 500 mA current, and multiple channels can be connected in parallel to achieve higher current output capacity. The circuit can be widely used in relay drive, lighting drive, display screen drive (LED), stepping motor drive and logic buffer.

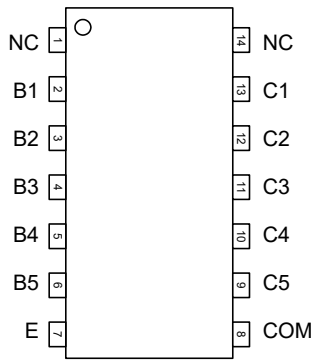
2.Features

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

3.Applications

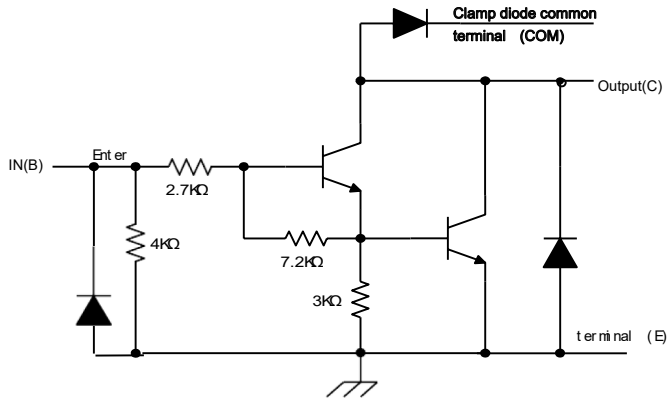
- Relay drive
- Indicator light driver
- Display screen driver

4.Pinning Information



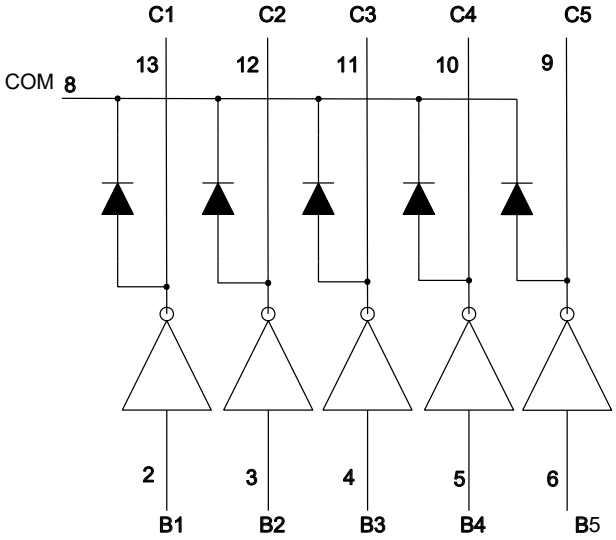
SOP-14

5.Circuit Schematic (Single Darlington Driver Circuit)



Schematic diagram of ULN2002D single circuit Darlington drive circuit

6.Logic Diagram



Pin Descriptions

Pin Number	Pin Names	Input/Output	Description
1	NC	-	Over hanging pins
2	B1	I	1-channel inputpin
3	B2	I	2-channel input pin
4	B3	I	3-channel input pin
5	B4	I	4-channel input pin
6	B5	I	5-channel input pin
7	E	-	Grounding
8	COM	-	Clamp diode common
9	C5	O	5-channel output pin
10	C4	O	4-channel output pin
11	C3	O	3-channel output pin
12	C2	O	2-channel output pin
13	C1	O	1-channel output pin
14	NC	-	Overhanging pins

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

Parameter	Symbol	value	Units
Collector emitter voltage (13-9 pins)	V_{CE}	50	V
COM terminal voltage (8 pins)	V_{COM}	50	V
Input voltage (2-6 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}	-2	A
Packaging thermal impedance (1)(2)(3)	θ_{JA}	125	°C/W
Maximum operating junction temperature	T_J	150	°C
Welding temperature		260	°C,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

8.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 (SOP14)	I_{OUT}	Continuous output< T_A=85°C		60	mA/ch
Input Voltage	V_{IN}			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		0.8	W
SOP14		T_A=85°C		0.32	W

Note: 1. T_A represents the ambient temperature of the circuit

2. The calculation method of circuit power consumption is: $P_D=V_{CE(ON)1}\times I_{C1}+ V_{CE(ON)2}\times I_{C2}+ V_{CE(ON)3}\times I_{C3} + V_{CE(ON)4}\times I_{C4}+ V_{CE(ON)5}\times I_{C5}+ V_{IN1}\times I_{IN1}+ V_{IN2}\times I_{IN2}+ V_{IN3}\times I_{IN3}+ V_{IN4}\times I_{IN4}+ V_{IN5}\times I_{IN5}$

3. In Note 2, $V_{CE(ON)n}$ represents the conduction voltage drop of the corresponding channel, where n=1,2,3,4,5, and ICn represents the average load current of the corresponding channel, where n=1,2,3,4,5; VINn represents the average high level of the signal input for the corresponding channel, where n=1,2,3,4,5; IINn represents the average signal input current of the corresponding channel, where n=1,2,3,4,5.

9.Electrical Parameter Characteristic Table

(T_A=25°C, unless otherwise specified)

Parameter	Test Chart	Conditions			Min.	Typ.	Max.	Units
$V_{I(ON)}$ On -state input voltage	Figure 4	V_{CE}=1.5V (input not current limited)	T_A=0°C	I_C=30mA		1.74	2.1	V
				I_C=60mA		1.79	2.15	
				I_C=120mA		1.85	2.2	
				I_C=240mA		1.96	2.35	
				I_C=350mA		2.09	2.5	
			T_A=25°C	I_C=30mA		1.65	2	
				I_C=60mA		1.69	2	
				I_C=120mA		1.73	2.1	
				I_C=240mA		1.82	2.2	
				I_C=350mA		1.93	2.3	
		I_I=800uA (V_{CE}<1.5V)	T_A=0°C	I_C=30mA		2.14	2.57	
				I_C=60mA		2.17	2.6	
				I_C=120mA		2.22	2.66	
				I_C=240mA		2.33	2.8	
				I_C=350mA		2.44	2.93	
			T_A=25°C	I_C=30mA		2.17	2.6	
				I_C=60mA		2.2	2.64	
				I_C=120mA		2.25	2.7	
				I_C=240mA		2.35	2.82	
				I_C=350mA		2.45	2.94	

Parameter	Test Chart	Conditions			Min.	Typ.	Max.	Units
$V_{I(ON)}$ On -state input voltage	Figure 4	I_I=1mA (V_{CE}<1.5V)	T_A=0°C	I_C=30mA		2.45	2.94	V
				I_C=60mA		2.48	2.98	
				I_C=120mA		2.54	3.05	
				I_C=240mA		2.65	3.18	
				I_C=350mA		2.77	3.32	
			T_A=25°C	I_C=30mA		2.5	3	
				I_C=60mA		2.53	3.04	
				I_C=120mA		2.58	3.1	
				I_C=240mA		2.69	3.23	
				I_C=350mA		2.8	3.36	
$V_{CE(SAT)}$ Collector emitter saturation voltage drop	Figure 3	V_I=2.4V (I_I>800uA)	T_A=0°C	I_C=30mA		0.81		
				I_C=60mA		0.86		
				I_C=120mA		0.94		
				I_C=240mA		1.12		
				I_C=350mA		1.3		
			T_A=25°C	I_C=30mA		0.76		
				I_C=60mA		0.81		
				I_C=120mA		0.88		
				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		7.03		mA
				V_I=6V		3.27		
				V_I=4.5V		2.16		
				V_I=2.4V		0.88		
			T_A=25°C	V_I=12V		6.5		
				V_I=6V		3.05		
				V_I=4.5V		2.04		
				V_I=2.4V		0.85		
Clamp diode forward voltage drop (Figure 6)	V_F	I_F=350mA	T_A=0°C			1.56	1.6	V
			T_A=25°C			1.55	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 5)	I_R	V_R=50V					50	μA
Low high transmission delay (Figure 7)	t_{PLH}	V_L=12V, R_L=45Ω				0.15	1	μs
Transmission delay high low (Figure 7)	t_{PHL}	V_L=12V, R_L=45Ω				0.15	1	μs

10.Electrical Parameter Testing Schematic Diagram

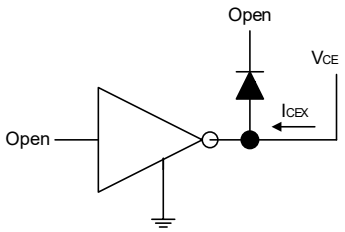


Figure 1. I_{CEX} Test Circuit

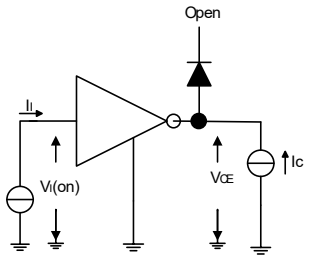


Figure 2. I_I Test Circuit

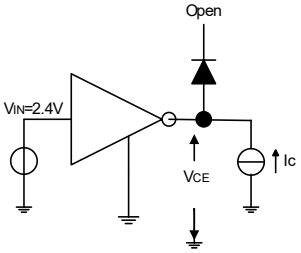


Figure 3. $V_{CE(sat)}$ Test Circuit

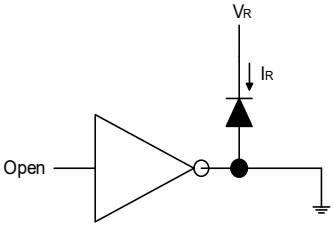


Figure 4. I_R Test Circuit

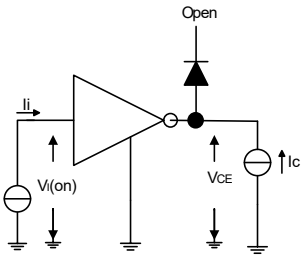


Figure 5. $V_{I\ (on)}$ Test Circuit

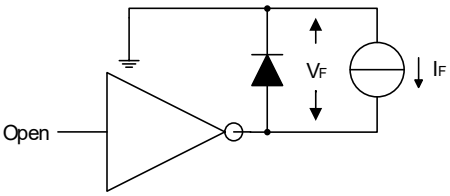


Figure 6. V_F Test Circuit

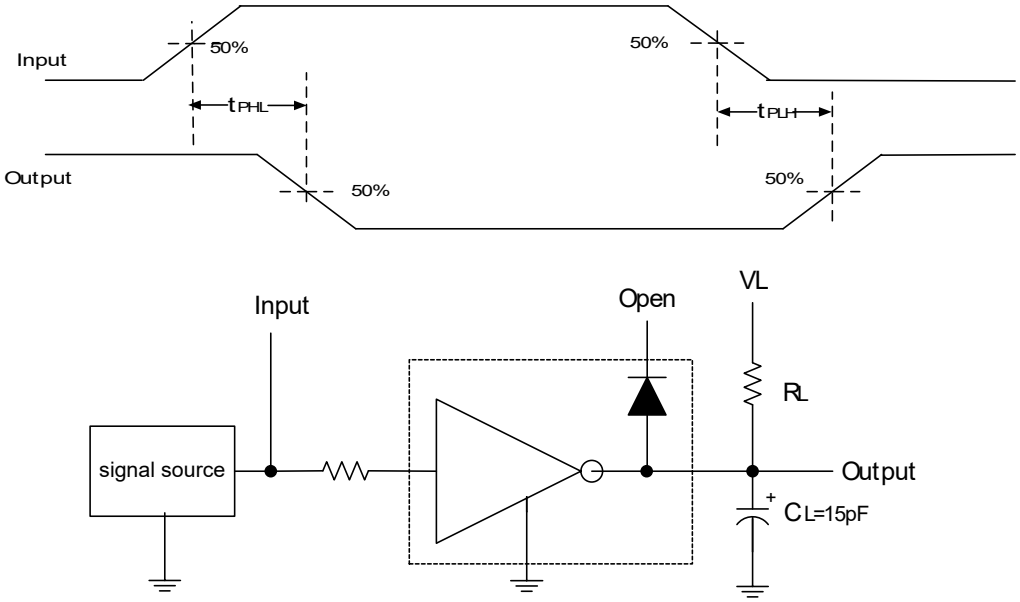


Figure 7. Transmission delay waveform

Note: The capacitive load in Figure 7 is the parasitic capacitance of the oscilloscope probe.

11.Typical Characterisitics

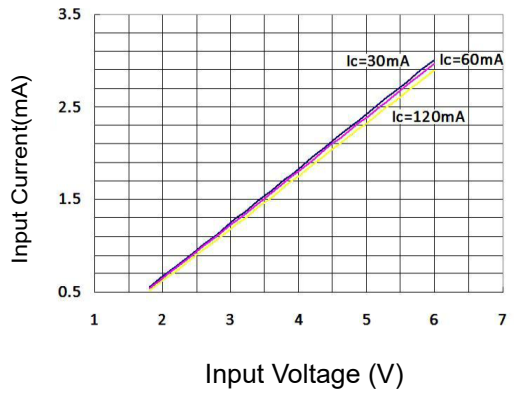


Figure 8: The relationship between input current and input voltage

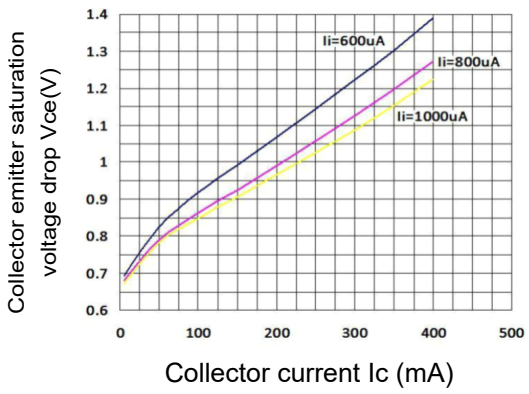


Figure 9: The relationship between collector emitter saturation voltage drop and collector current

12.Application Information

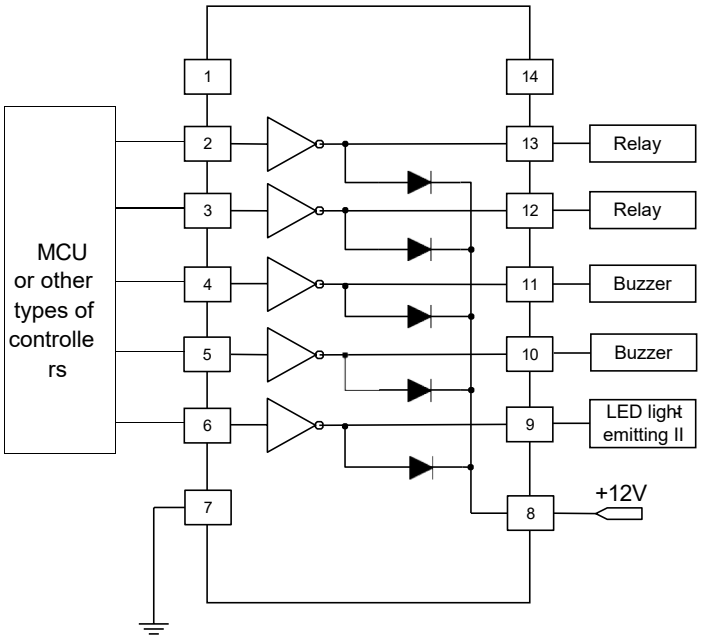


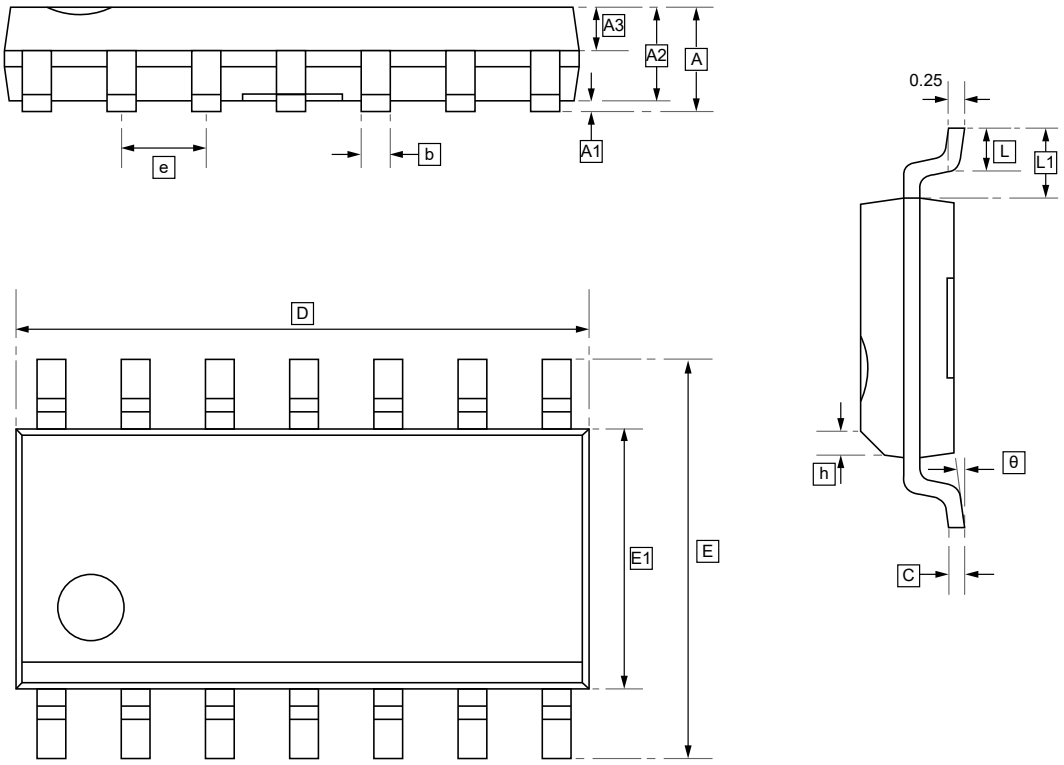
Figure 10. Typical application circuit diagram of ULN2002D

The application of ULN2002D is not limited to the application circuit diagram shown in Figure 10. In particular, the drive circuit load can be 5 relays or 5 LED's. The specific application depends on the actual situation. Figure 10 only shows the load types that can be driven by ULN2002D. In addition to the load type shown in Figure 10, ULN2002D can also drive stepping motor, toy motor and other loads.

Although ULN2002D is not a CMOS type electrostatic sensitive device, appropriate anti-static measures should be taken in actual use to avoid leakage, function failure and other situations when the device is subjected to too strong electrostatic pulse impact.

ULN2002D is widely used in relay drive circuits. When controlling 220V and other strong currents, special attention should be paid to the isolation between strong current and weak current to prevent strong current signals from coupling to the output end of the drive circuit, causing device breakdown and other failures.

13.SOP-14 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	A3	b	C	D	E	E1	e	h	L
Min	-	0.05	1.35	0.65	0.203	0.17	8.45	5.80	3.80	1.24	0.25	0.40
Max	1.75	0.25	1.55	0.75	0.305	0.25	8.85	6.20	4.00	1.30	0.50	0.80

Symbol	L1	θ
Min	1.00	0°
Max	1.10	8°

14.Ordering Information

yww: Batch Code

Order Code	Package	Base QTY	Delivery Mode
UMW ULN2002D	SOP-14	2500	Tape and reel

15.Disclaimer

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