

1. DESCRIPTION

The XL2803CD device is a 50-V, 500-mA Darlington transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500 mA. The Darlington pairs can be connected in parallel for higher current capability.

Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. The XL2803CD device has a 2.7-k Ω series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices.

2. FEATURES

- 500-mA-rated collector current
(single output)
- High-voltage outputs: 50 V
- Output clamp diodes
- Inputs compatible with various types of logic
- Package option: XL2803CD (SOP20)

3. APPLICATIONS

- Factory automation and control
- Building automation
- Appliances
- IP network camera
- HVAC valve & actuator control
- Relay, solenoid, and lamp driving
- Stepper motor driving

4. PIN CONFIGURATIONS AND FUNCTIONS

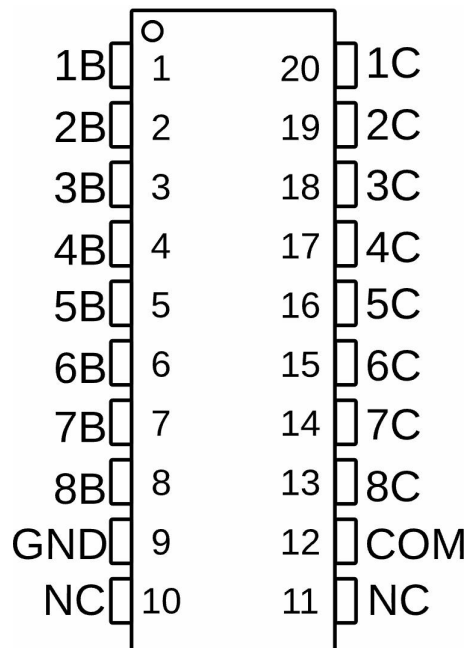
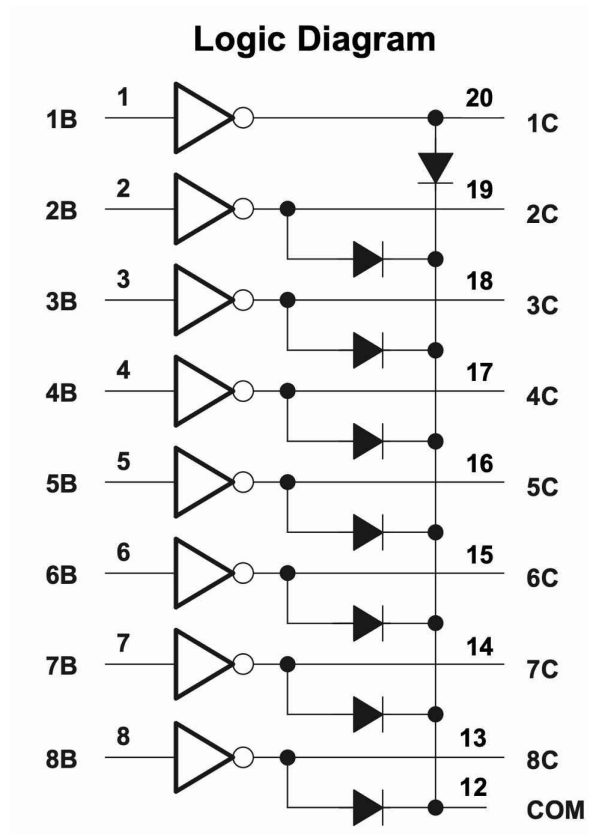


Table 5-1. Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
1B	1	I	Channel 1 through 8 Darlington base input
2B	2		
3B	3		
4B	4		
5B	5		
6B	6		
7B	7		
8B	8		
1C	20	O	Channel 1 through 8 Darlington collector output
2C	19		
3C	18		
4C	17		
5C	16		
6C	15		
7C	14		
8C	13		
GND	9	—	Common emitter shared by all channels (typically tied to ground)
COM	12	I/O	Common cathode node for flyback diodes (required for inductive loads)
NC	10, 11	—	No connect pin

5. LOGIC DIAGRAM



6. SPECIFICATIONS

6.1 Absolute Maximum Ratings

at 25°C free-air temperature (unless otherwise noted)^[1]

		MIN	MAX	UNIT
V_{CE}	Collector-emitter voltage		50	V
V_i	Input voltage ^[2]		30	V
	Peak collector current		500	mA
$I(\text{clamp})$	Output clamp current		500	mA
	Total substrate-terminal current		-2.5	A
T_j	Junction temperature	-65	150	°C
T_{stg}	Storage temperature	-65	150	°C

[1] Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

[2] All voltage values, unless otherwise noted, are with respect to the emitter/substrate terminal GND.

6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ^[1]	±2000
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002 ^[2]	±500

[1] JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

[2] JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V_{CE}	Collector-emitter voltage	0	50	V
T_A	Ambient temperature	-40	85	°C

6.4 Thermal Information

THERMAL METRIC ^[1]		XL2803CD	UNIT
		SOP20	
		20 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	68.8	°C/W
$R_{\theta JC(\text{top})}$	Junction-to-case (top) thermal resistance	34.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	37.5	°C/W
ψ_{JT}	Junction-to-top characterization parameter	10.7	°C/W
ψ_{JB}	Junction-to-board characterization parameter	37.0	°C/W
$R_{\theta JC(\text{bot})}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

6.5 Electrical Characteristics

at $T_A = 25^\circ\text{C}$ free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS	XL2803CD			UNIT
		MIN	TYP	MAX	
I_{CEX} Collector cutoff current	$V_{CE} = 50\text{ V}$, see Figure 7-1 $I_I = 0$			50	μA
$I_{I(off)}$ Off-state input current	$V_{CE} = 50\text{ V}$, $T_A = 70^\circ\text{C}$ $I_C = 500\text{ }\mu\text{A}$, see Figure 7-2	50	65		μA
$I_{I(on)}$ Input current	$V_I = 3.85\text{ V}$, See Figure 7-3		0.93	1.35	mA
$V_{I(on)}$ On-state input voltage	$V_{CE} = 2\text{ V}$, see Figure 7-4			2.4	V
				2.7	
				3	
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_I = 250\text{ }\mu\text{A}$, see Figure 7-5			0.9	V
	$I_I = 350\text{ }\mu\text{A}$, see Figure 7-5			1	
	$I_I = 500\text{ }\mu\text{A}$, see Figure 7-5			1.3	
I_R Clamp diode reverse current	$V_R = 50\text{ V}$, see Figure 7-6			50	μA
V_F Clamp diode forward voltage	$I_F = 350\text{ mA}$, see Figure 7-7		1.7		V
C_i Input capacitance	$V_I = 0$, $f = 1\text{ MHz}$		15	25	pF

6.6 Switching Characteristics

$T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH} Propagation delay time, low- to high-level output	$V_S = 50\text{ V}$, $C_L = 15\text{ pF}$, $R_L = 163\text{ }\Omega$, See Figure 7-8		130		ns
t_{PHL} Propagation delay time, high- to low-level output			20		
V_{OH} High-level output voltage after switching	$V_S = 50\text{ V}$, $I_O = 300\text{ mA}$, see Figure 7-9	$V_S - 20$			mV

6.7 Typical Characteristics

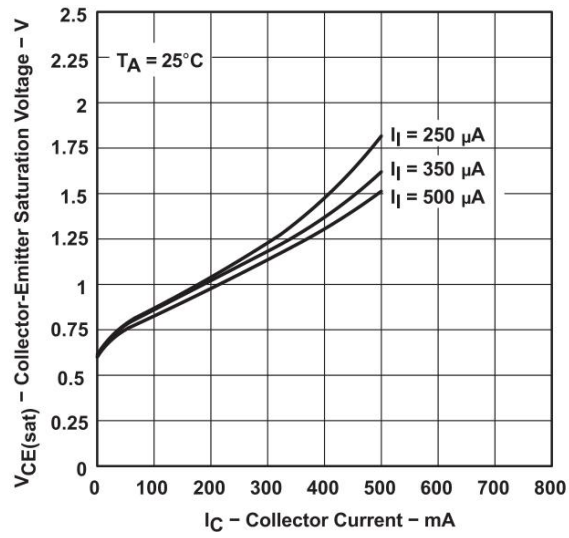


Figure 6-1. Collector-Emitter Saturation Voltage vs Collector Current (One Darlington)

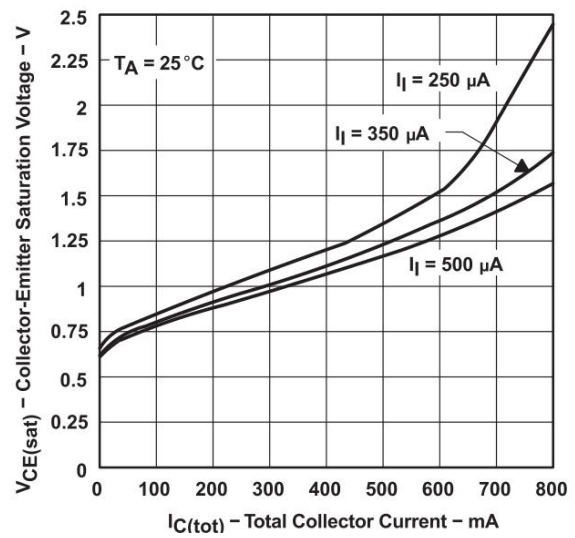


Figure 6-2. Collector-Emitter Saturation Voltage vs Total Collector Current (Two Darlings in Parallel)

7. PARAMETER MEASUREMENT INFORMATION

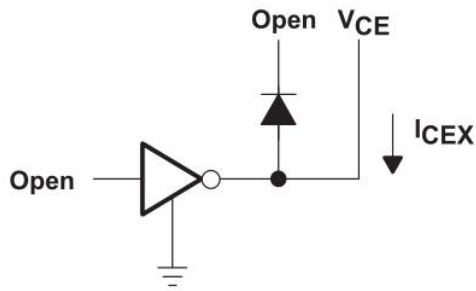


Figure 7-1. I_{CEX} Test Circuit

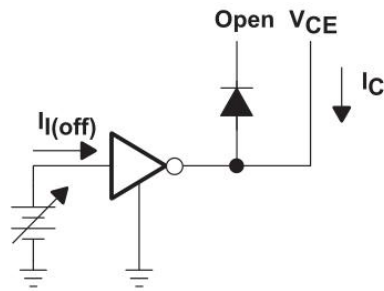


Figure 7-2. $I_{I(off)}$ Test Circuit

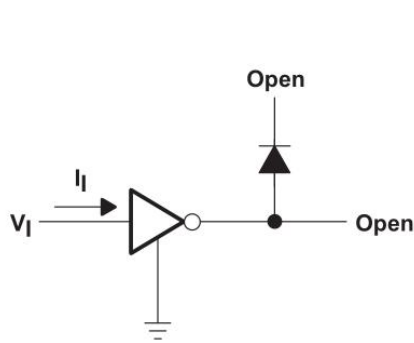


Figure 7-3. $I_{I(on)}$ Test Circuit

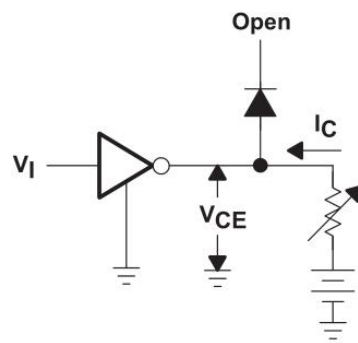


Figure 7-4. $V_{I(on)}$ Test Circuit

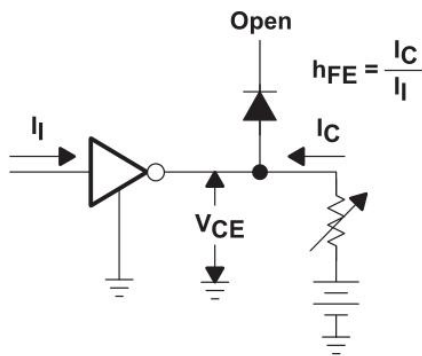


Figure 7-5. h_{FE} , $V_{CE(sat)}$ Test Circuit

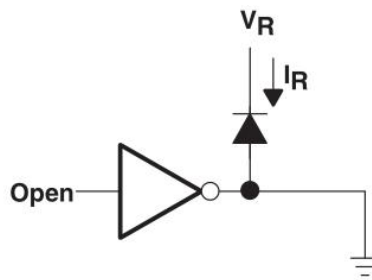


Figure 7-6. I_R Test Circuit

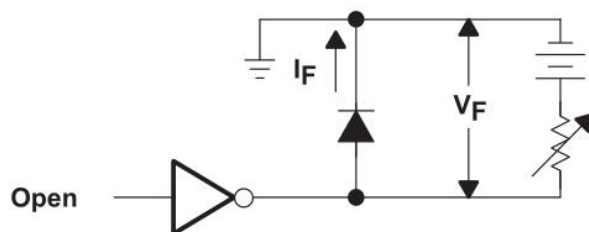
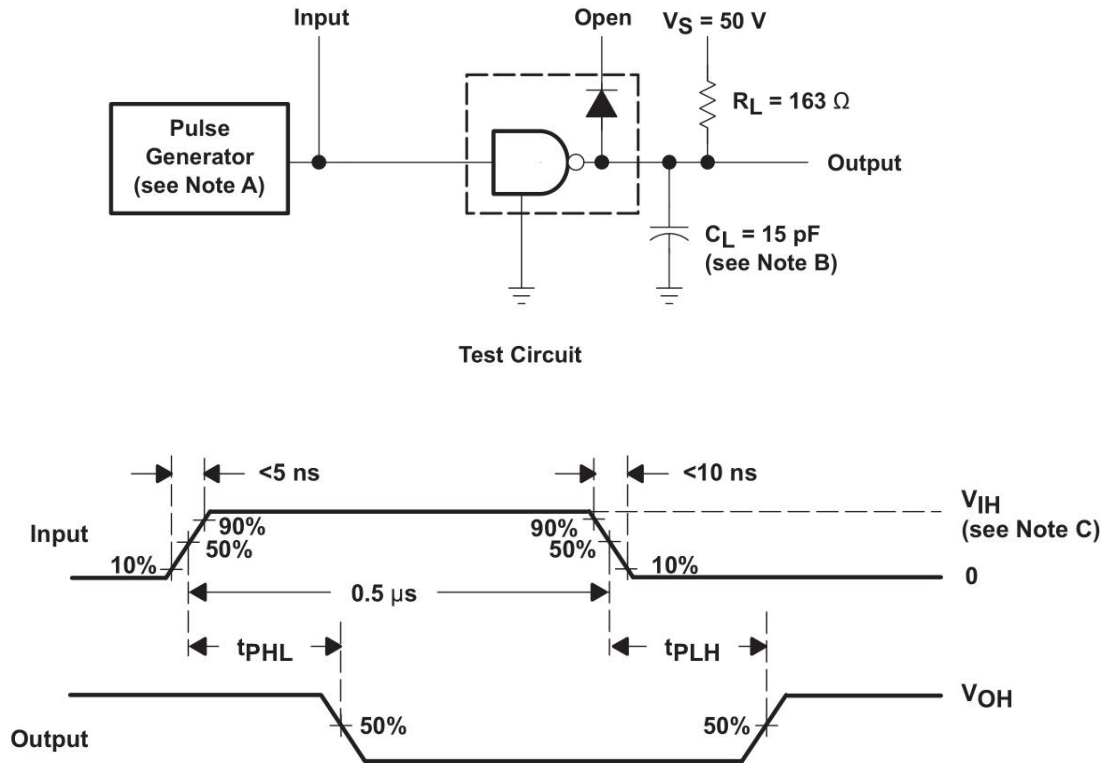
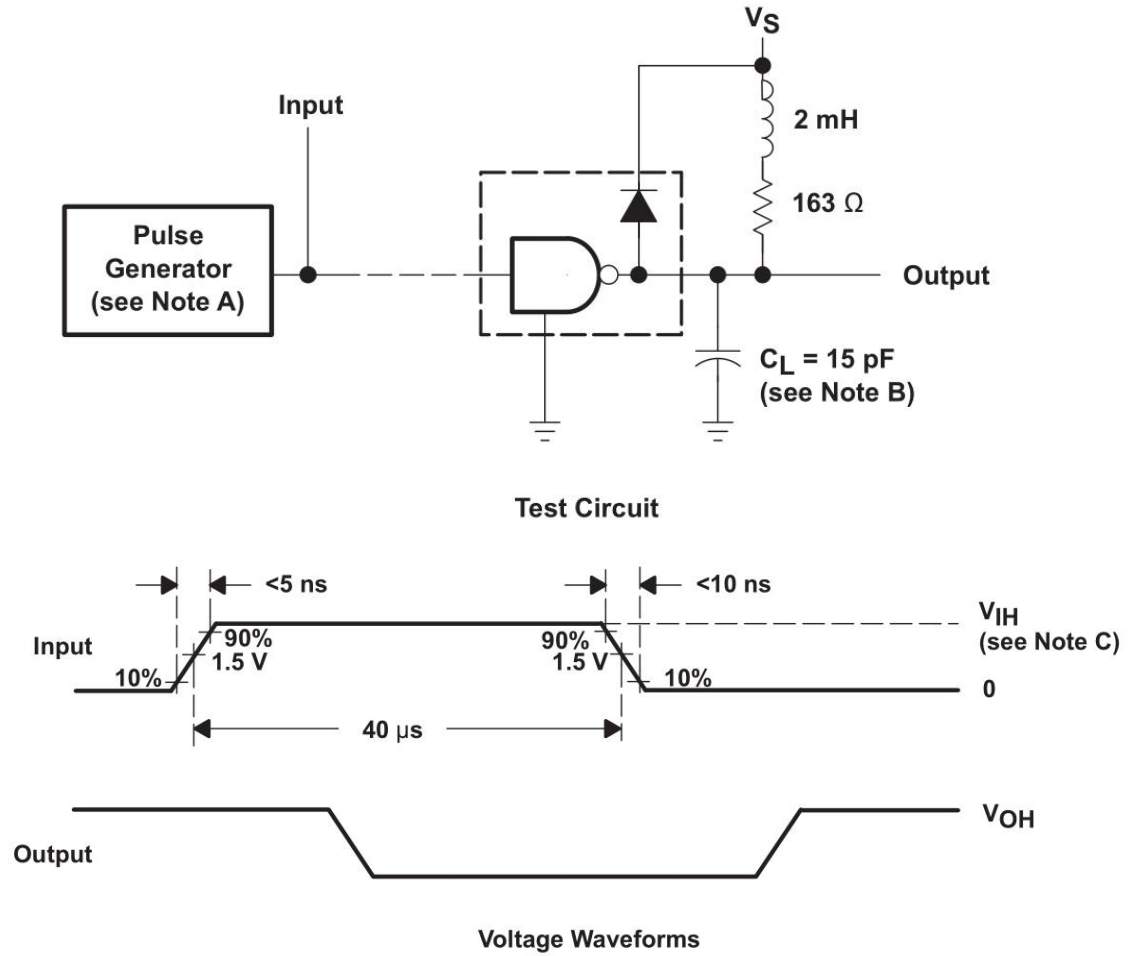


Figure 7-7. V_F Test Circuit



- A. The pulse generator has the following characteristics: PRR = 12.5 kHz, $Z_0 = 50 \Omega$.
- B. C_L includes probe and jig capacitance.
- C. $V_{IH} = 3 \text{ V}$.

Figure 7-8. Propagation Delay Times



- A. The pulse generator has the following characteristics: PRR = 12.5 kHz, $Z_o = 50 \text{ } \Omega$.
- B. C_L includes probe and jig capacitance.
- C. $V_{IH} = 3 \text{ V}$.

Figure 7-9. Latch-Up Test

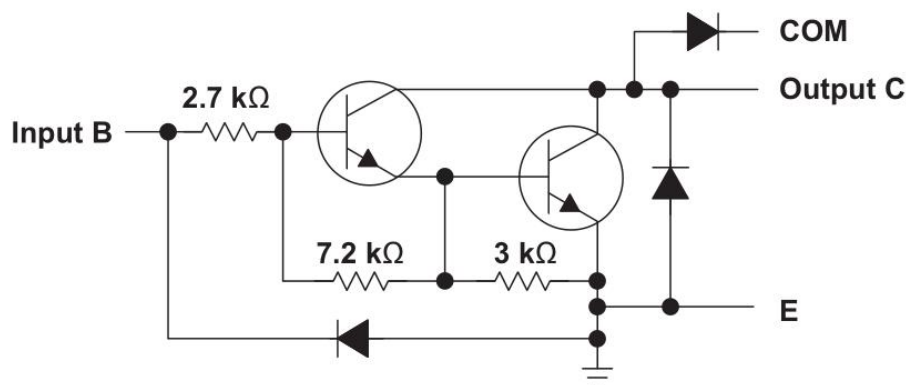
8. DETAILED DESCRIPTION

8.1. Overview

This standard device has proven ubiquity and versatility across a wide range of applications. This feature is due to its integration of eight Darlington transistors that are capable of sinking up to 500 mA and wide GPIO range capability.

The XL2803CD is comprised of eight high voltage, high current NPN Darlington transistor pairs. All units feature a common emitter and open collector outputs. To maximize their effectiveness, these units contain suppression diodes for inductive loads. The XL2803CD has a series base resistor to each Darlington pair, thus allowing operation directly with TTL or CMOS operating at supply voltages of 5 V or 3.3 V. The XL2803CD offers solutions to a great many interface needs, including solenoids, relays, lamps, small motors, and LEDs. Applications requiring sink currents beyond the capability of a single output can be accommodated by paralleling the outputs.

8.2. Functional Block Diagram



8.3. Feature Description

Each channel of XL2803CD consists of Darlington connected NPN transistors. This connection creates the effect of a single transistor with a very-high current gain. The very high β allows for high output current drive with a very-low input current, essentially equating to operation with low GPIO voltages.

The GPIO voltage is converted to base current through the 2.7-k Ω resistor connected between the input and base of the predriver Darlington NPN.

The diodes connected between the output and COM pin are used to suppress the kickback voltage from an inductive load that is excited when the NPN drivers are turned off (stop sinking) and the stored energy in the coils causes a reverse current to flow into the coil supply through the kickback diode.

In normal operation, the diodes on base and collector pins to emitter are reverse biased. If these diodes are forward biased, internal parasitic NPN transistors draw (a nearly equal) current from other (nearby) device pins.

8.4. Device Functional Modes

8.4.1 Inductive Load Drive

When the COM pin is tied to the coil supply voltage, XL2803CD can drive inductive loads and suppress the kickback voltage through the internal free wheeling diodes.

8.4.2 Resistive Load Drive

When driving resistive loads, COM can be left unconnected or connected to the load voltage supply. If multiple supplies are used, connect to the highest voltage supply.

9. APPLICATION AND IMPLEMENTATION

Note

Information in the following applications sections is not part of the Xinluda component specification, and Xinluda does not warrant its accuracy or completeness. Xinluda's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1. Application Information

XL2803CD is typically used to drive a high-voltage or current peripherals from an MCU or logic device that cannot tolerate these conditions. The following design is a common application of XL2803CD, driving inductive loads. This includes motors, solenoids, and relays. Each load type can be modeled by what is seen in [Figure 9-1](#).

9.2. Typical Application

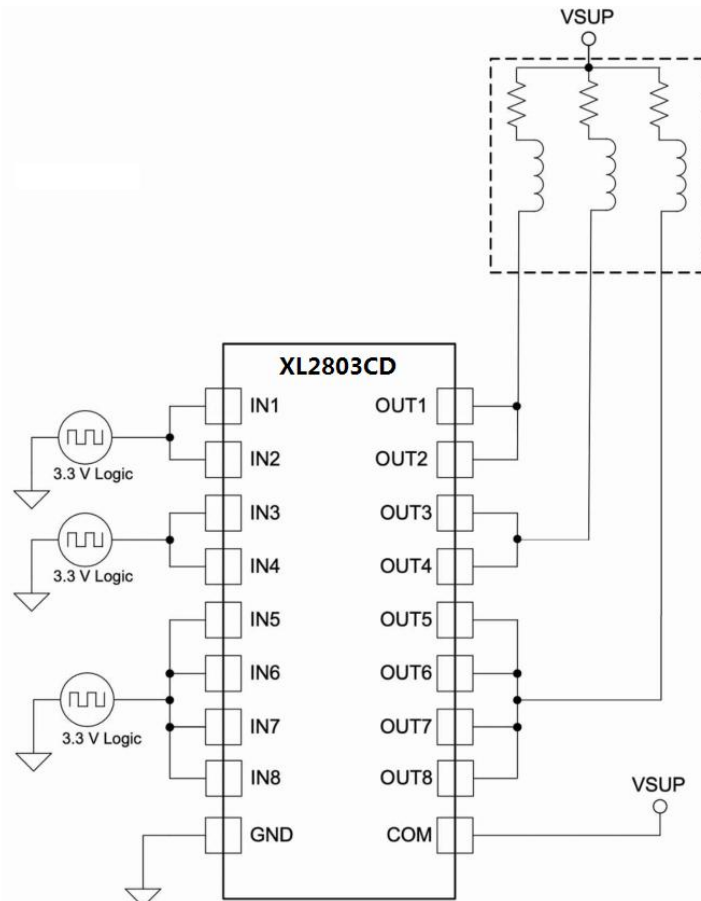


Figure 9-1. XL2803CD as Inductive Load Driver

9.2.1 Design Requirements

For this design example, use the parameters listed in [Table 9-1](#) as the input parameters.

Table 9-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
GPIO voltage	3.3 or 5 V
Coil supply voltage	12 to 50 V
Number of channels	8
Output current (RCOIL)	20 to 300 mA per channel
Duty cycle	100%

9.2.2 Detailed Design Procedure

When using XL2803CD in a coil driving application, determine the following:

- Input voltage range
- Temperature range
- Output and drive current
- Power dissipation

9.2.2.1 Drive Current

The coil current is determined by the coil voltage (V_{SUP}), coil resistance, and output low voltage (V_{OL} or $V_{CE(SAT)}$).

$$I_{COIL} = (V_{SUP} - V_{CE(SAT)}) / R_{COIL}$$

9.2.2.2 Output Low Voltage

The output low voltage (V_{OL}) is the same thing as $V_{CE(SAT)}$ and can be determined by [Figure 6-1](#), [Figure 6-2](#), or

9.2.2.3 Power Dissipation and Temperature

The number of coils driven is dependent on the coil current and on-chip power dissipation. To determine the number of coils possible, use [Equation 2](#) to calculate XL2803CD on-chip power dissipation P_D .

$$P_D = \sum_{i=1}^N V_{OLi} \times I_{Li}$$

where

- N is the number of channels active together.
- V_{OLi} is the OUT_i pin voltage for the load current I_{Li} . This is the same as $V_{CE(SAT)}$.

To ensure the reliability of XL2803CD and the system, the on-chip power dissipation must be lower than or equal to the maximum allowable power dissipation (P_D) dictated by [Equation 3](#).

$$P_{D(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

where

- $T_{J(MAX)}$ is the target maximum junction temperature.
- T_A is the operating ambient temperature.
- θ_{JA} is the package junction to ambient thermal resistance.

XINLUDA recommends to limit the XL2803CD IC die junction temperature to $< 125^{\circ}\text{C}$. The IC junction temperature is directly proportional to the on-chip power dissipation.

9.2.3 Application Curves

The following curves are generated with XL2803CD driving an OMRON G5NB relay – $V_{in} = 5.0\text{ V}$; $V_{sup} = 12\text{ V}$ and $R_{COIL} = 2.8\text{ k}\Omega$.

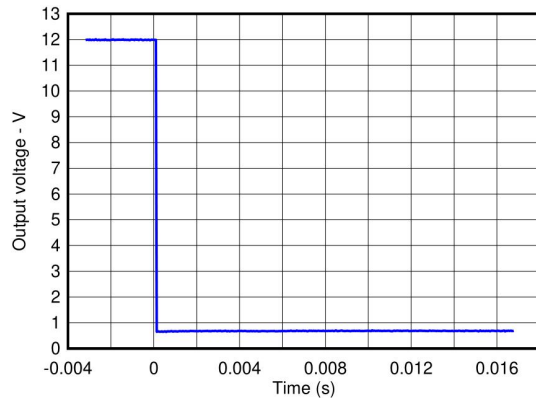


Figure 9-2. Output Response with Activation of Coil (Turn-On)

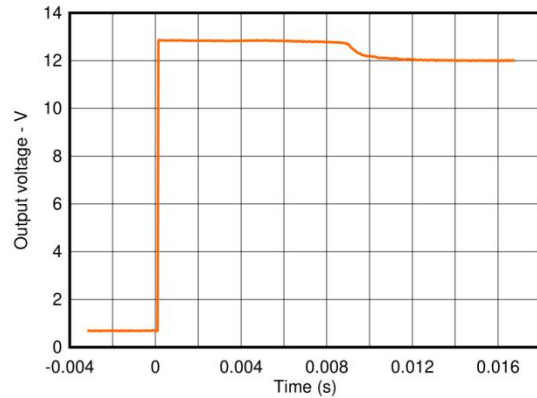


Figure 9-3. Output Response with De-activation of Coil (Turn Off)

9.3. Power Supply Recommendations

This device does not need a power supply; however, the COM pin is typically tied to the system power supply. With this case, make sure that the output voltage does not heavily exceed the COM pin voltage. This action can heavily forward bias the flyback diodes and cause a large current to flow into COM, potentially damaging the on-chip metal or overheating the part.

9.4. Layout

9.4.1 Layout Guidelines

Thin traces can be used on the input due to the low current logic that is typically used to drive XL2803CD. Take care to separate the input channels as much as possible, as to eliminate crosstalk. TI recommends thick traces for the output to drive high currents as desired. Wire thickness can be determined by the trace material current density and desired drive current.

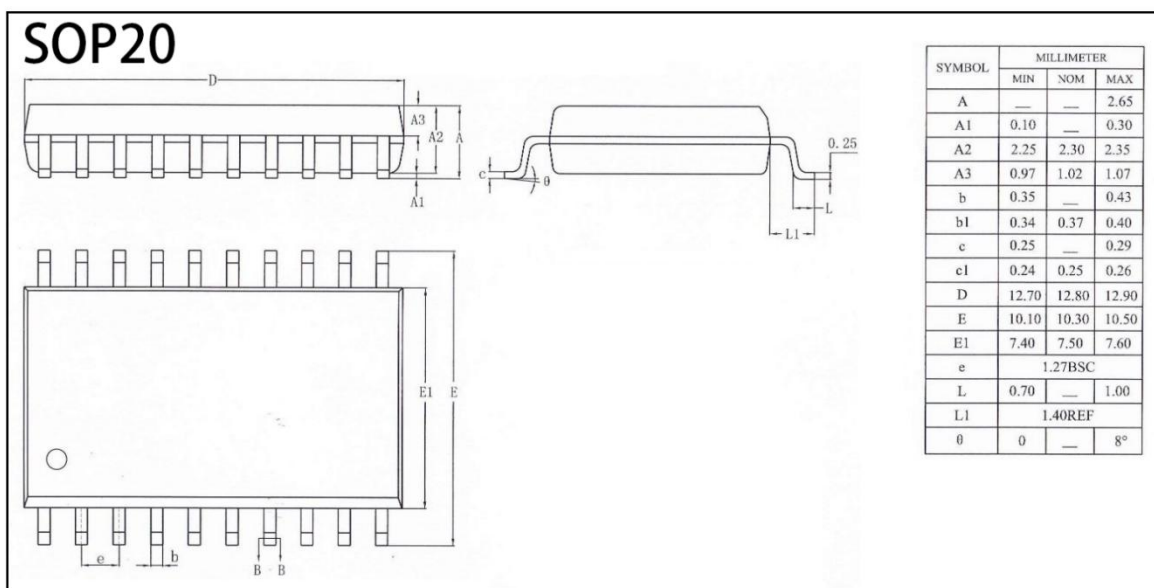
Because all of the channels currents return to a common emitter, size that trace width to be very wide. Some applications require up to 2.5 A.

10. ORDERING INFORMATION

Ordering Information

Part Number	Device Marking	Package Type	Body size (mm)	Temperature (°C)	MSL	Transport Media	Package Quantity
XL2803CD	XL2803CD	SOP20	12.90 * 7.5	-40 to 85	MSL3	T&R	1000

11. DIMENSIONAL DRAWINGS



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